NAVAL FIGHTERS NUMBER SEVENTY - SEVEN

CURTISS XBTC-2 "EGGBEATER"

BY BOB KOWALSKI

INTRODUCTION:

Bob Kowalski has helped me immensely over the years with information and leads to complete the difficult projects covered by the Naval Fighters Series. As a author, he first wrote Naval Fighters #20, the Grumman AF "Guardian" hunter/killer aircraft duo which he flew from escort carriers in the early 1950s. His interest in the late war Bomber Torpedo (BT) Program and specifically the Martin AM-1/1Q "Mauler" resulted in Naval Fighter #24. This in turn resulted in our combined desire to document all the experimental aircraft developed in WWII in not only the BT, but the similar Scout Bomber (SB) and the Torpedo Bomber (TB) Programs. This desire has now been fulfilled with this, the last book in the series, the Curtiss XBTC-2. The four other books covering these aircraft are: #30 the Douglas XSB2D-1 & BTD-1 "Destroyer", #36 the Douglas XTB2D-1 "Skypirate", #48 the Kaiser Fleetwings XBTK-1, and #62 the Curtiss XBT2C-1.

Unlike the other previously covered BT aircraft, the XBTC-1 was primarily a research aircraft. Almost no operational or weapons testing was ever conducted on this aircraft. All testing was focussed on the duplex wing concept and on the counter-rotating propellers.

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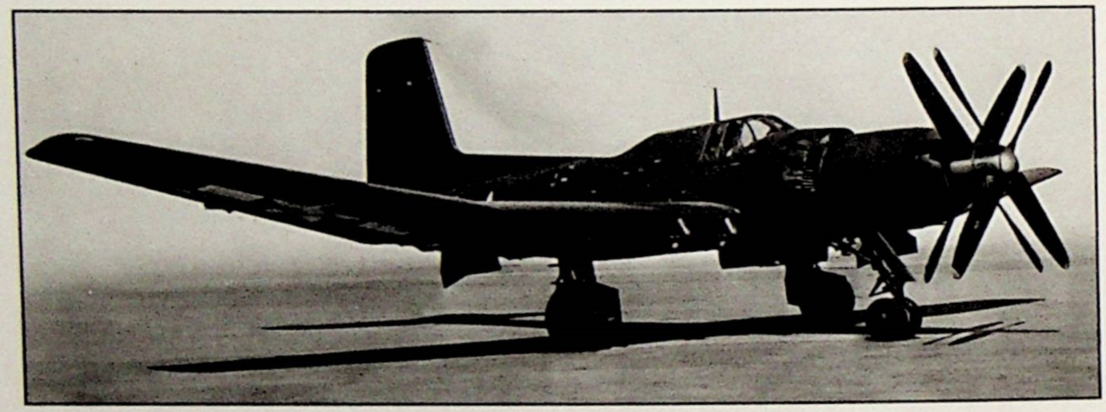
Steve Ginter, 1754 Warfield Cir., Simi Valley, California, 93063

FRONT COVER: XBTC-2 BuNo 31402 in slow flight with gear, duplex flaps and slats extended.

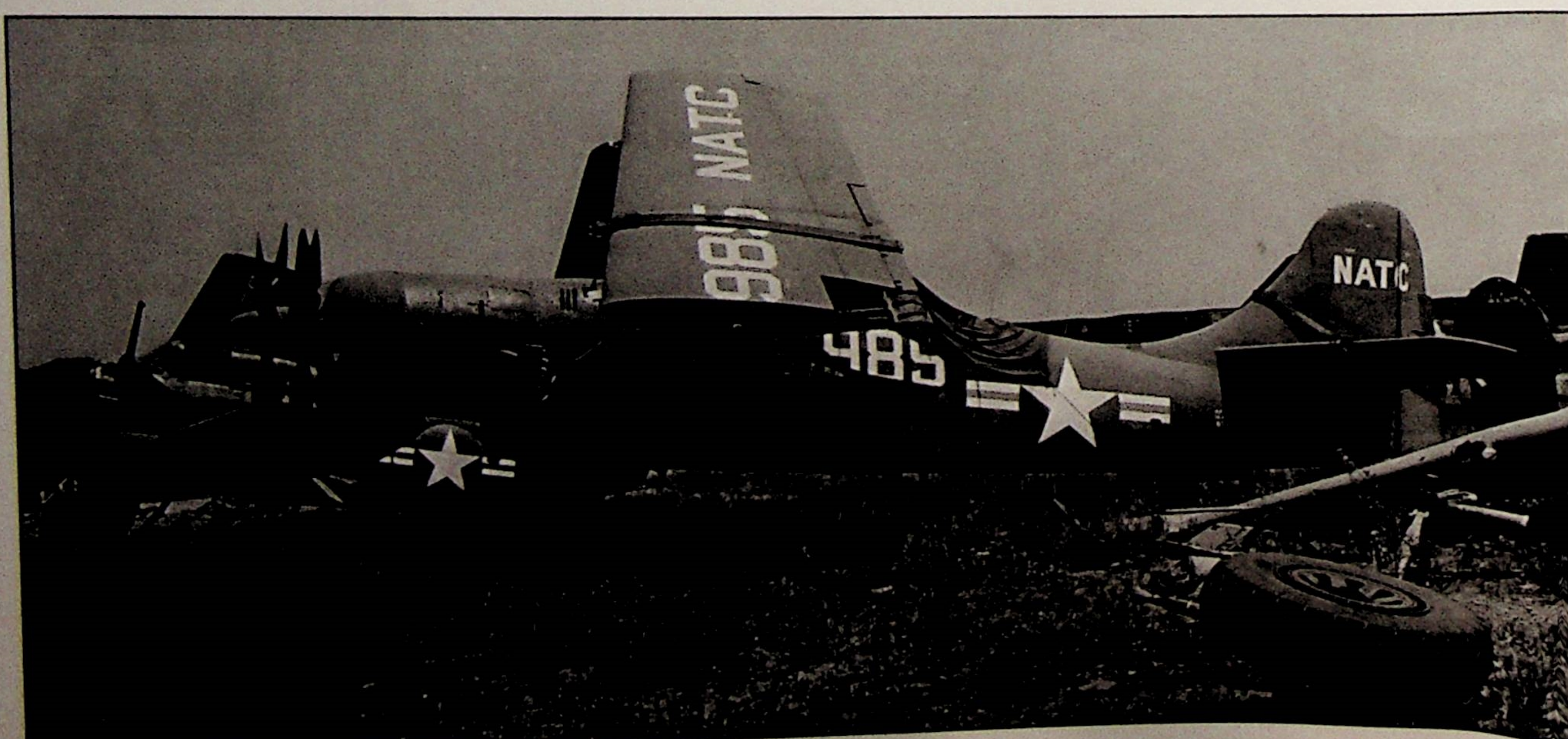
BACK COVER: Top and bottom, BuNo 31401 in the markings of Service Test at NATC on 17 November 1946. Note open bomb bay doors and swept-back wings. (NMNA)

CONTRIBUTORS:

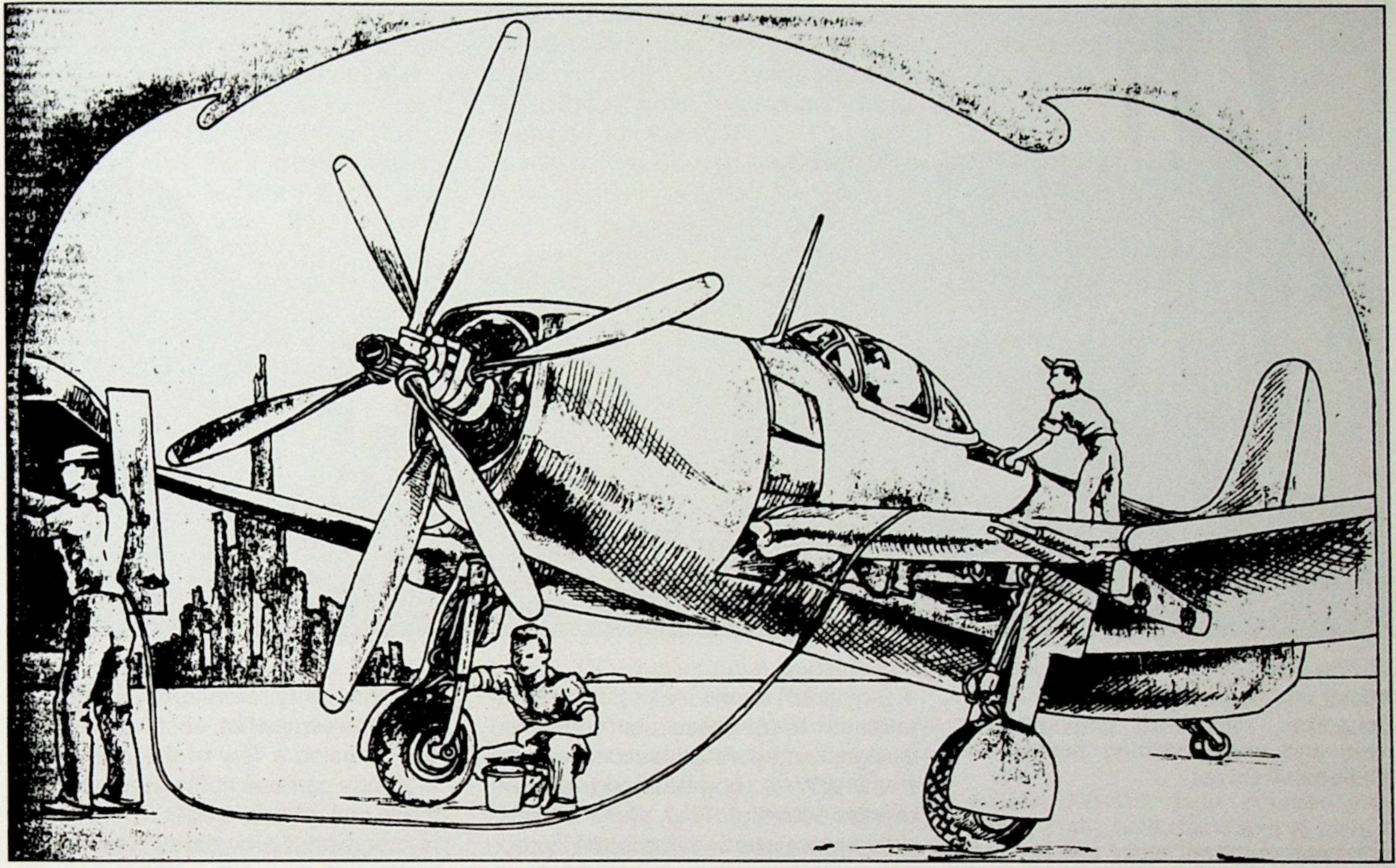
Peter Bowers, Harry Gann, Craig Kaston, Wayne Morris, Norm Taylor, and Nick Williams.



Above, the Navy tested four aircraft fitted with counter-rotating propellers, which included the largest single engine carrier capable prop aircraft, the Douglas XTB2D-1 "Skypirate" (see Naval Fighters #36). (Harry Gann) Below, Boeing's counter-rotating prop powered heavy fighter bomber, the XF8B-1 (see Naval Fighters #65) sits in the boneyard at NAF Philadelphia, PA, in the early '50s. In the background is XBTC-2 BuNo 31401 with canvas covering the engine section. (NMNA)



CURTISS XBTC-2 BY BOB KOWALSKI



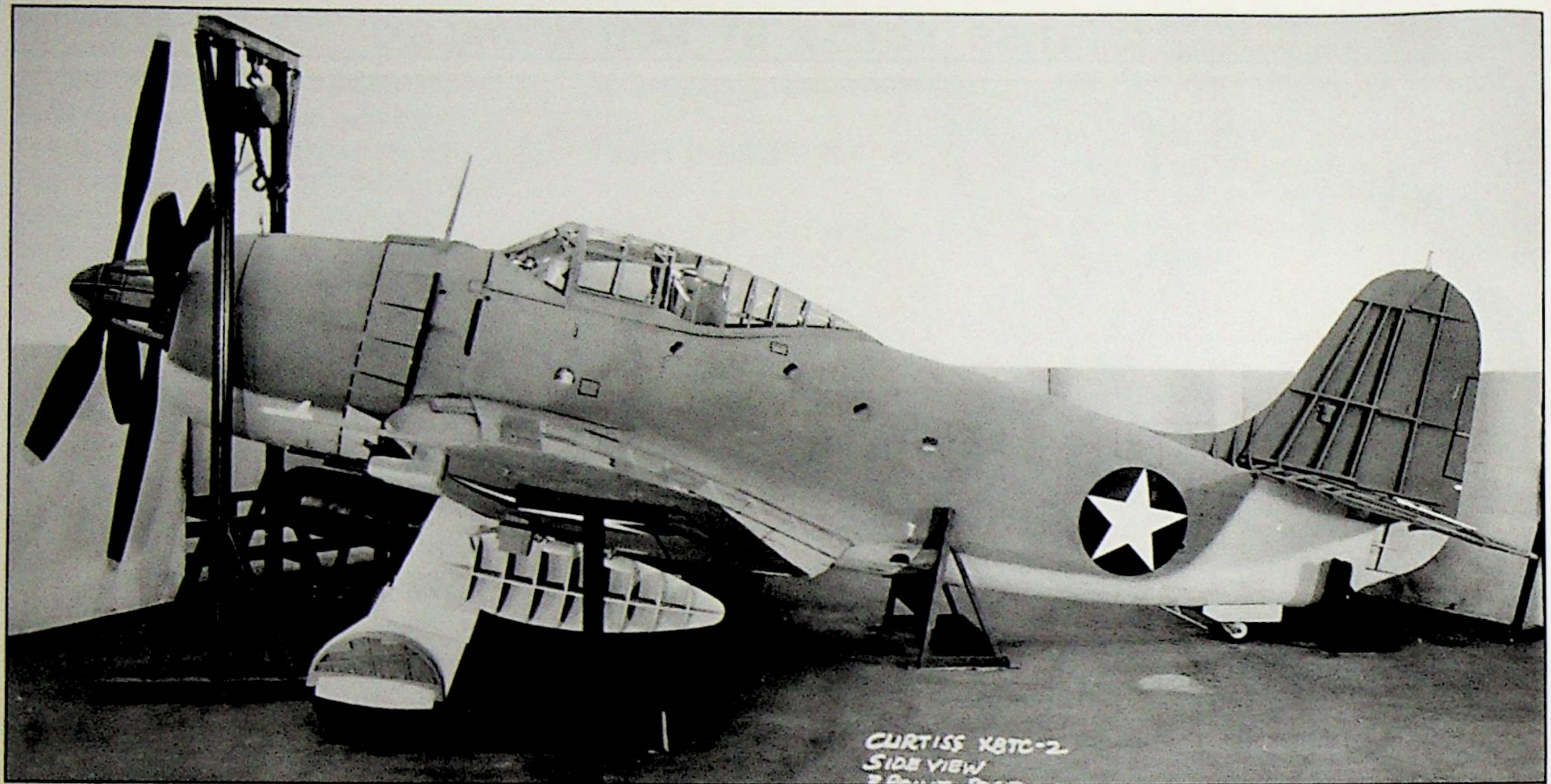
The Curtiss XBTC-1 was the first airplane designed to meet the January 1942 BuAer requirement for a single-engined, single-place, carrier-based airplane to replace the pre-war two-place VSB airplanes then in, or about to enter, the fleet. As the first airplane of this new Bomber Torpedo class, the XBTC-1 (Curtiss Model 96) would be powered by the Wright Cyclone R-3350-8 engine. Armament was four 20mm cannons and it was capable of dive-bombing and torpedo attacks. Although advanced in concept, the XBTC-1 was to have used the existing state-of-the-art aerodynamic technology as a way to facilitate its production.

In June 1942, Curtiss Wright's Columbus Division submitted a proposal that covered the requested R-3350-powered model as well as an alternate version to be powered by the new, promising Pratt & Whitney R-4360 Wasp Major engine. To ensure the carrier suitability of this heavier R-4360-powered model, two changes were made to the original design. The first included a two-foot extension of the wing plus a new high-lift system, the duplex flaps. The second change was to the use of a contra-rotating propeller to handle the additional power of the R-4360. After the design details were worked out, a letter of intent was issued in late June 1942 for four experimental prototypes, two R-3350-powered XBTC-1s and two, R-4360-powered XBTC-2s.

Although the R-3350 was introduced in 1937 and did power several large, experimental airplanes including the Martin XPB2M Mars and the Douglas XB-19, it was still undergoing development. After the US's entry into WW II however, the vast majority of that engine's production would be needed for the Army Air Corp's strategic long-range bombers: primarily the Boeing B-29 and the Consolidated B-32 scheduled for operational use in 1943. That need plus continuing difficulties with Wright's development of the R-3350 probably contributed to the decision to abandon the XBTC-1 to concentrate on the newer, more powerful XR-4360. Consequently, a contract for prototype development of two XBTC-2s (BuNos 31401 & 31402) was awarded on 31 December 1942[1].

Above, crude maintenance manual illustration of the XBTC-2 showing filler location of the fuselage fuel tanks.

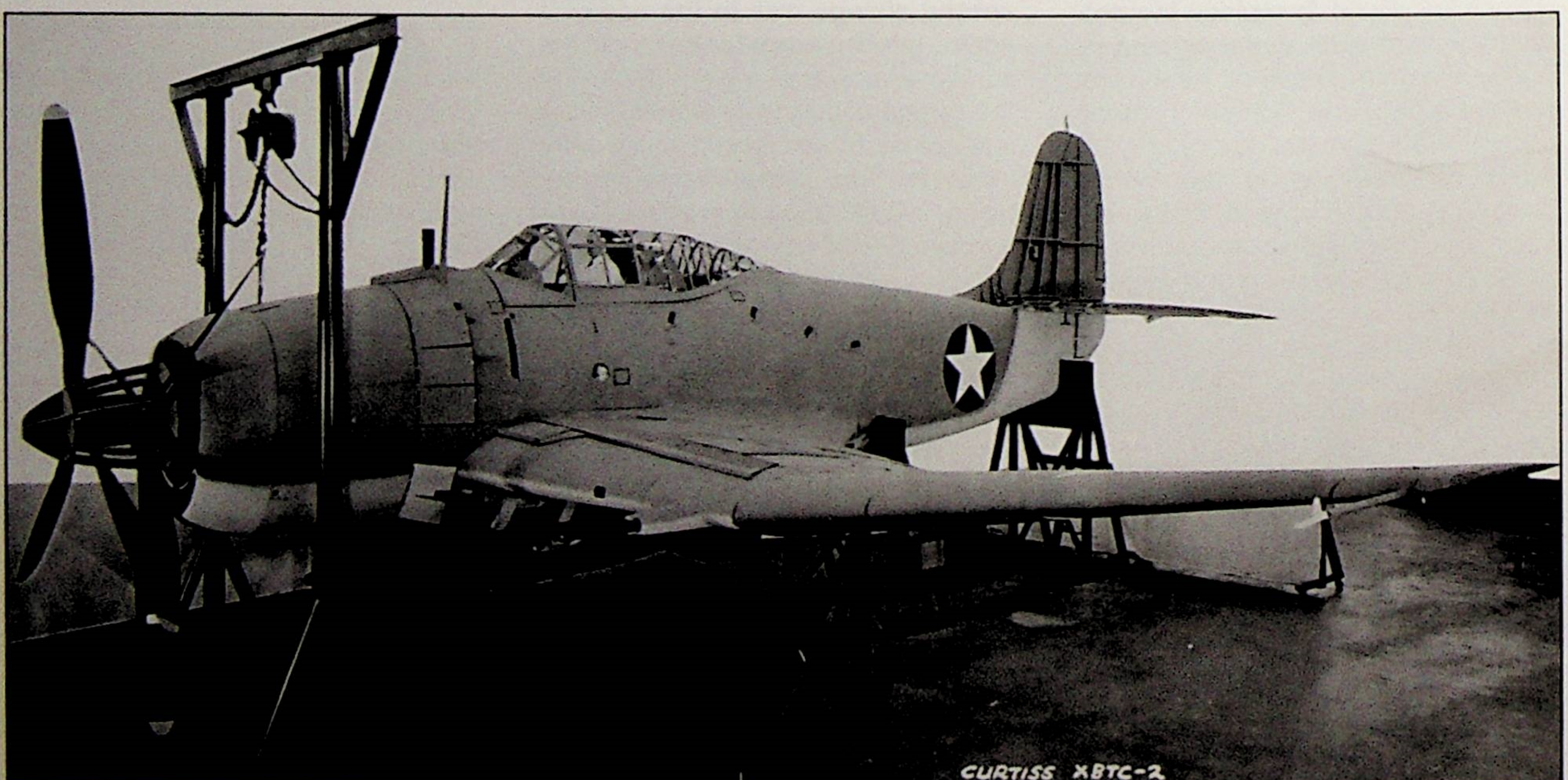
In addition to the well-documented production delays and service entry problems of the SB2C, an additional demand was placed on the engineering department at Columbus by the need for a new improved scout observation seaplane. As a consequence, the Navy assigned a high priority status to the XSC-1 program while continuing the XBTC-2 as a low-priority project. As a consequence of that low-priority, the first flight of the XBTC-2, BuNo 31401, took place in January 1945. To put



Above and below, XBTC-2 mock-up in December 1942 with conventional wing and contra-rotating propellers. (National Archives)

that date in perspective with its more advanced contemporaries, the Martin XBTM-1 (the AM-1 Mauler) had flown while the Douglas XBT2D-1 (the AD-1 Skyraider) would make its first flight in March 1945. These later-conceived designs incorporated lessons learned from WW II combat and offered greater potential. That, plus the previously-mentioned production problems, relegated the two XBTC-2s to limited experimental use in the development of new technologies.

A lack of documents makes tracing the early development of the XBTC-2 somewhat sketchy at best, but by using a few of the early photographs perhaps some sense can be made out of this stage. The earliest photographs are dated December 1942 and are of the XBTC-2 prototype mock-up. We'll use those in conjunction with the National Archives photos dated 28 April 1945 (identified further as conventional wing Model A)



and 12 February 1946 (the Model B) to visualize the design's evolution. The first difference between the mock-up and the airplanes is in the size (and shape) of its empennage. The smaller empennage of the mock-up could imply that its tailplane was a carry-over from the R-3350-powered XBTC-1 design. But once the R-4360 was to be its engine, that engine's greater weight (3650 lbs vs. the R-3350's 2646 lbs) and power would have required an increase in the area of the tail surfaces. The additional weight of this larger empennage helped balance the increased engine weight while its increased area would help control the increased engine power. The differing horsepower of their engines meant that the XBTC-1 and -2 would need different propellers. The XBTC-1's powerplant was to consist of the R-3350 engine and a conventional three-bladed propeller, while the XBTC-2 would use a six-bladed, contra-rotating propeller to handle the R-4360's greater horsepower.

The XBTC-2 was unique in that it was tested with two different wings. The two wings were conventional (Model A) and Duplex (Model B). Duplex means "twice as many" and as used on the XBTC-2 literally means an additional set of landing flaps. To add to the confusion, wind tunnel testing revealed aerodynamic problems with the duplex flaps so two different outer wing panels were designed for the XBTC-2. The first, known as the Conventional or Model A wing, had a new, conventional outer panel, with an increased span of 2 feet. This outer panel had a leading edge that was perpendicular to the airplane's thrust line and a trailing edge that continued the forward taper of the inner panel's trailing edge. Its aileron extended inboard from the wing tip to about 3/4 of the outer panel at wing station 1875, with the remaining length of the outer wing panel's trailing edge occupied by a portion of the wing flaps.

The second wing was the Model B wing and featured the duplex outer panel. This duplex outer panel had a leading edge that swept back in line with the inner wing panel's rearward taper, and now a trailing edge that was perpendicular to the airplane's thrust line. Its aileron then extended the full length of the outer panel while the duplex flap was located on the outer panel's lower surface just ahead of the aileron. The span-wise airflow on both wing models would have benefitted from the addition of a fence at the break in the leading edge of the Model A wing or the trailing edge of the the Model B wing.

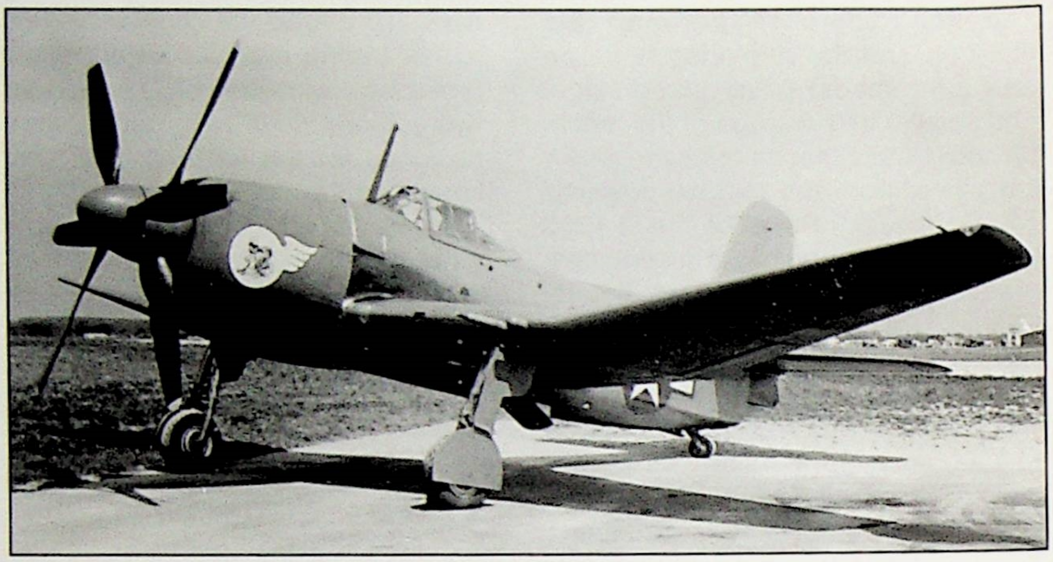
The mock-up featured the conventional wing with slats on its outer panel. Then, by comparing the 28 April 1945 (Conventional Wing) and 12 February 1946 (Model B) in similar 3/4 front left-side views, you sense that the conventional wing had more dihederal than the model B. However, that's an illusion because the outer panels of both wings had 10° of dihederal. It's probably the sweep-back of the Model B's leading edge that contributes to that illusion.

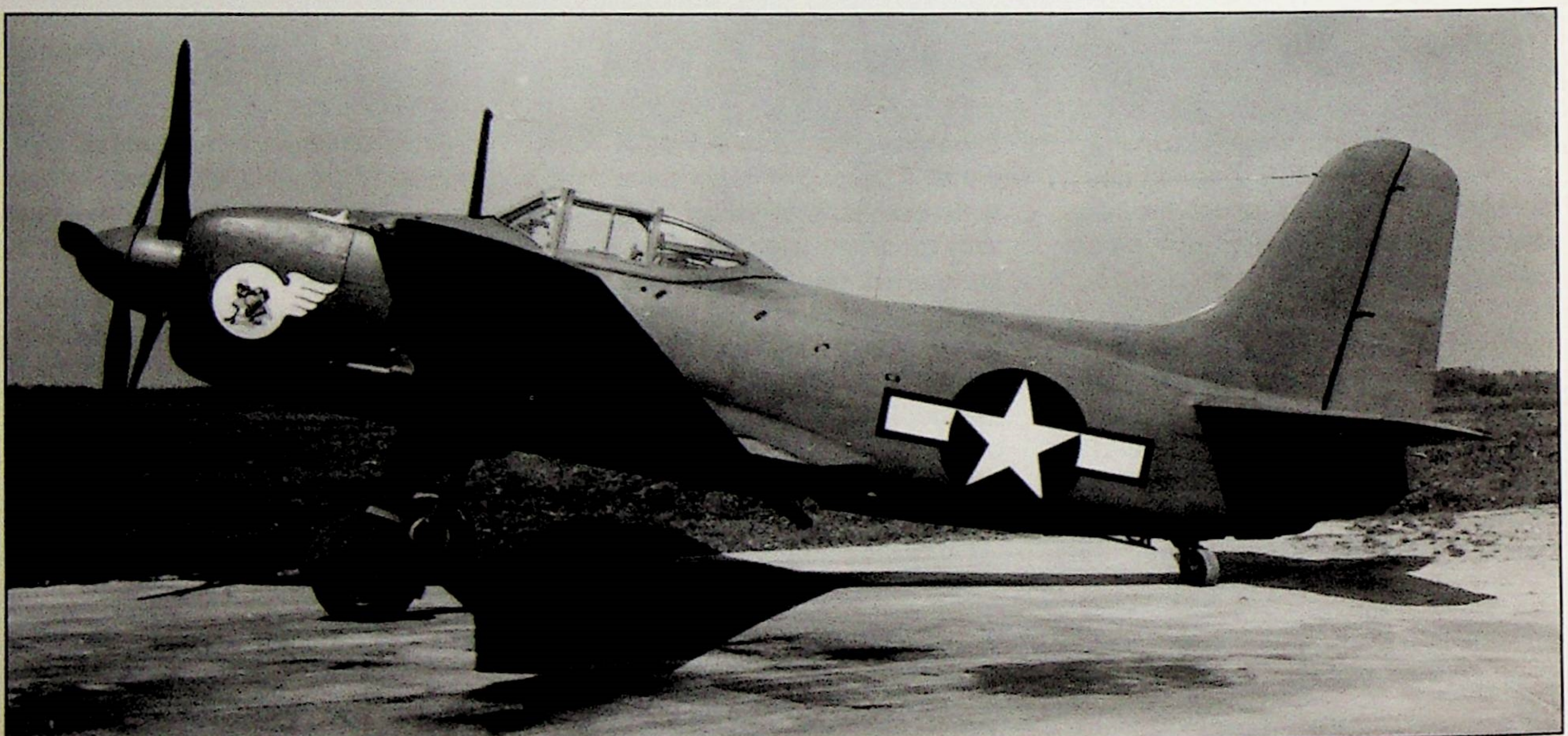
The next distinguishing feature is the external differences between the contra-rotating propellers. The propeller on the conventional-winged model of 28 April 1945 was without

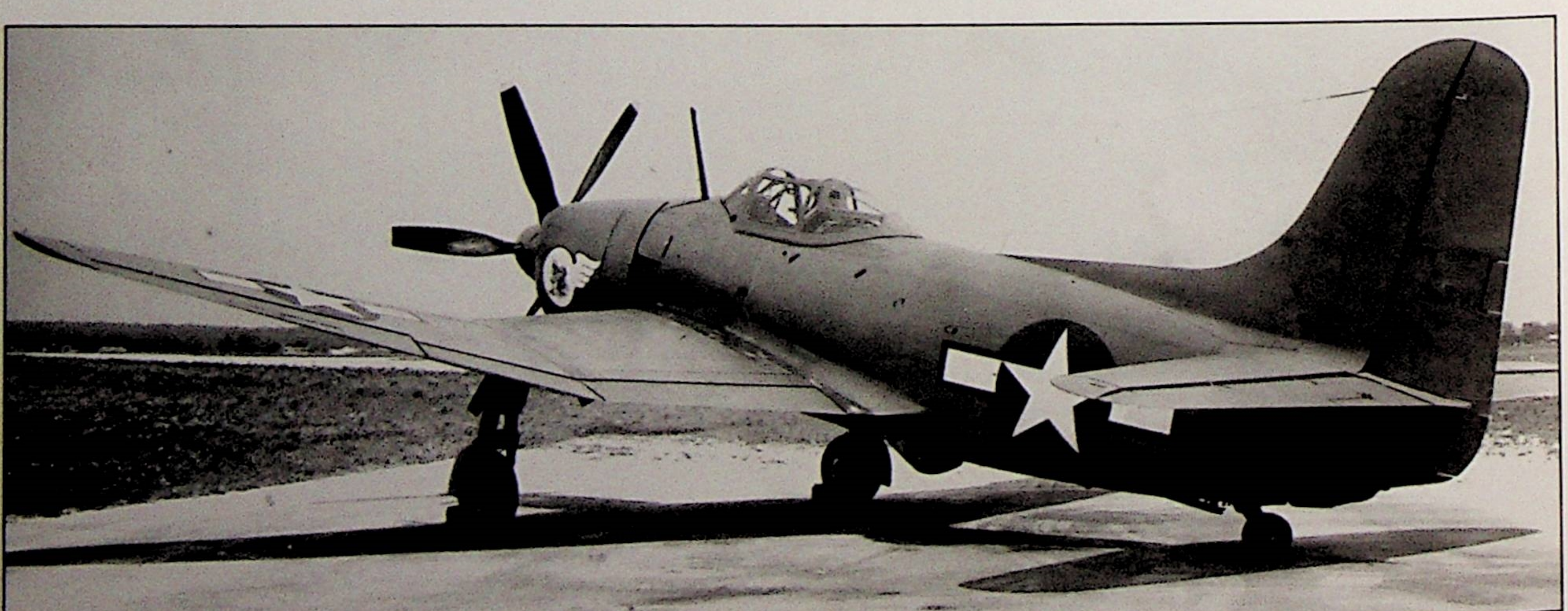
Below, XBTC-2 ship number one, BuNo 31401 with the Model A wing at the Curtiss plant on Christmas Eve 1944. It is fitted with a Curtiss propeller less spinner and cuffs. (National Archives)

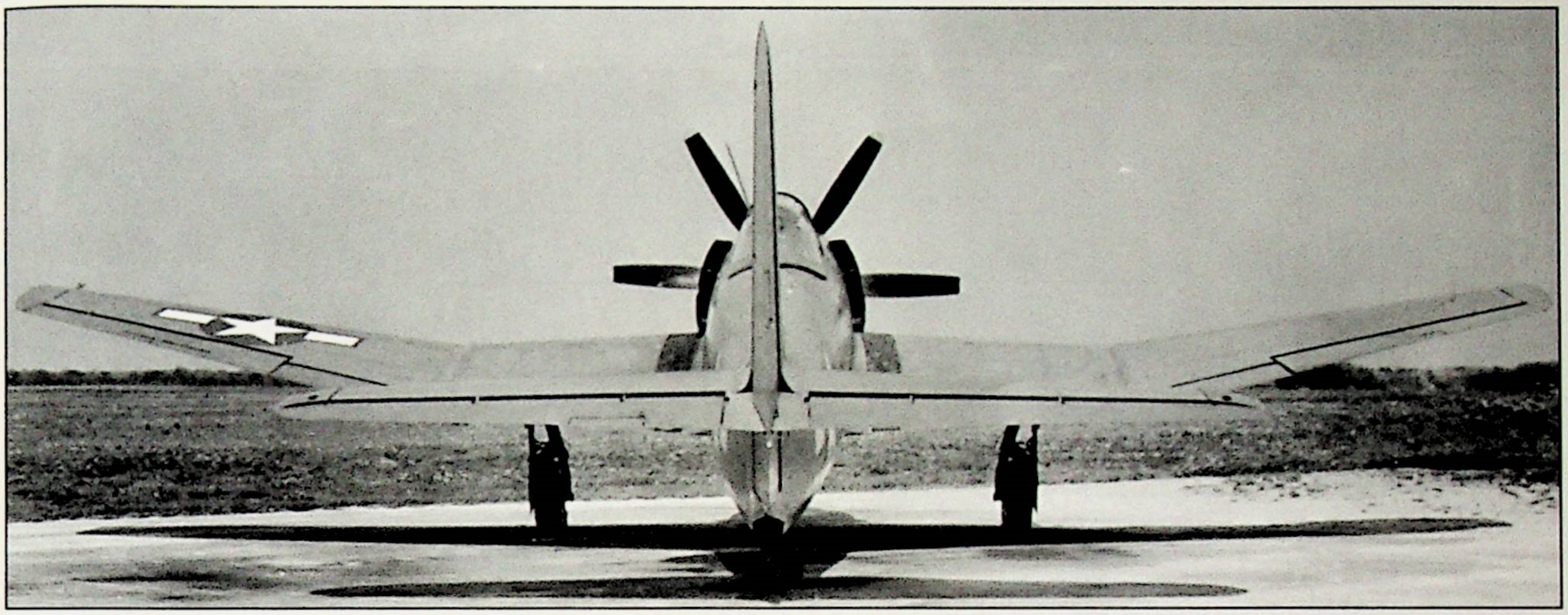
CONVENTIONAL MODEL A WING ON XBTC-2 NUMBER ONE BuNo 31401

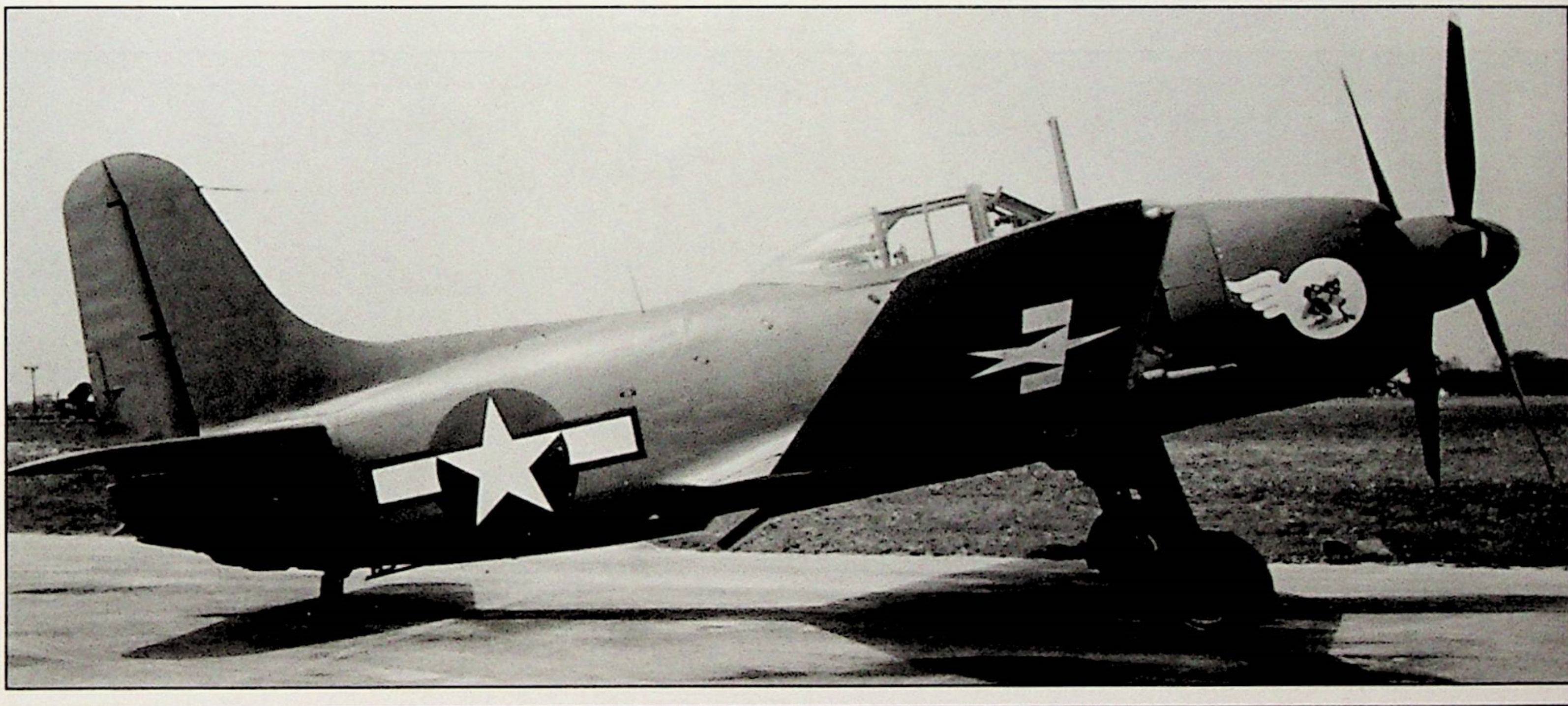
Above, for the 28 April 1945 photo shoot a very large Pratt & Whitney "Wasp" logo was applied to ship one's engine cowl, probably much to the chagrin of the Curtiss Wright engine division.



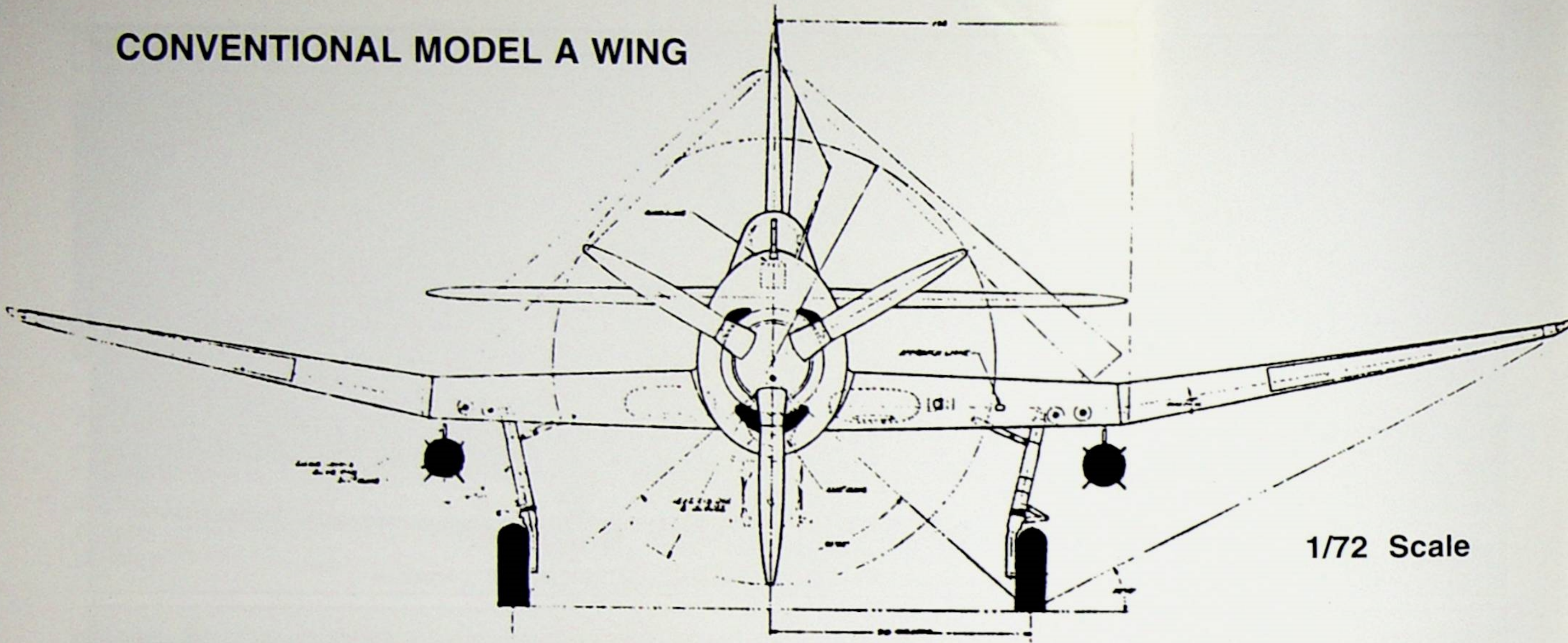




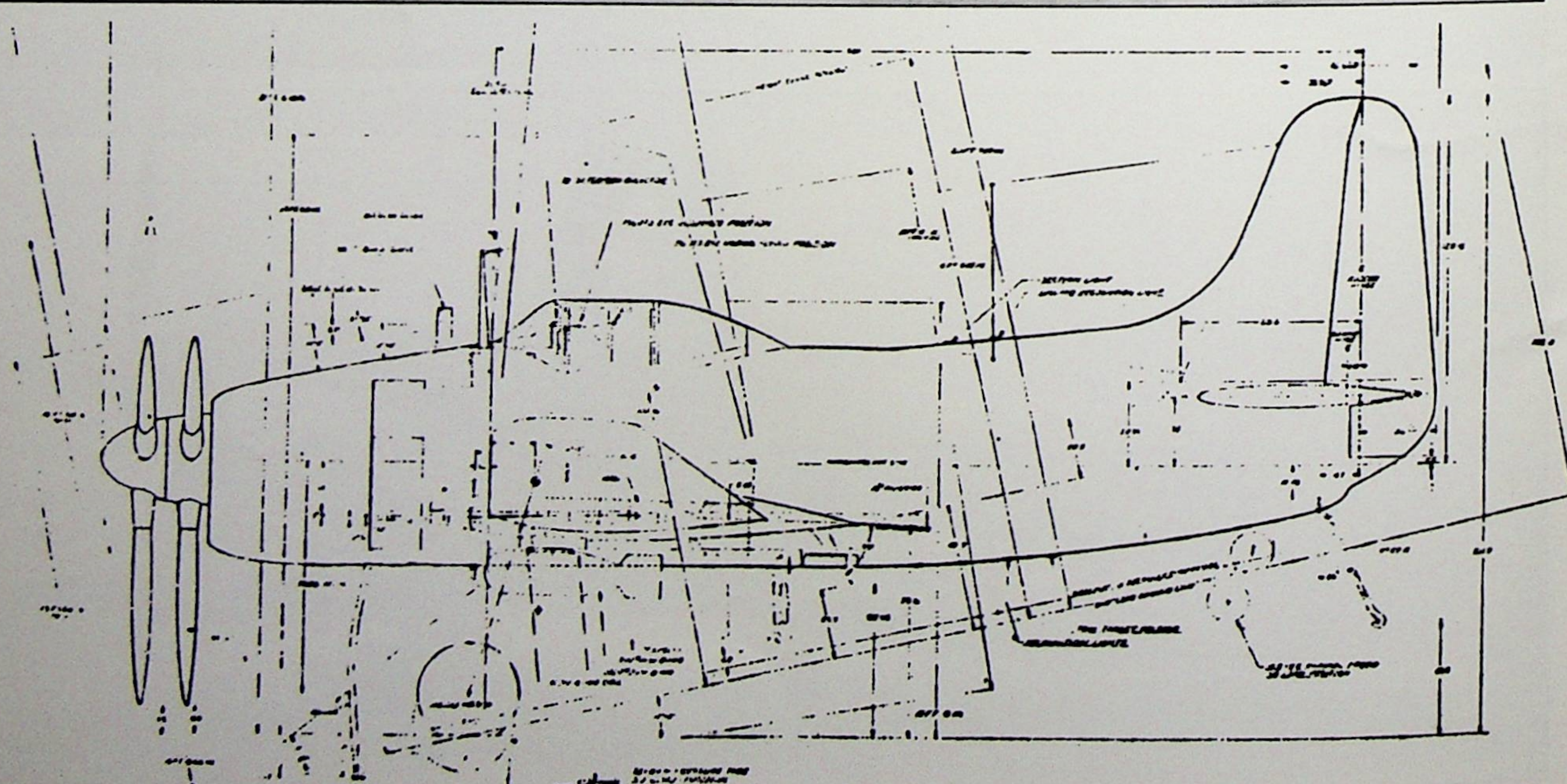




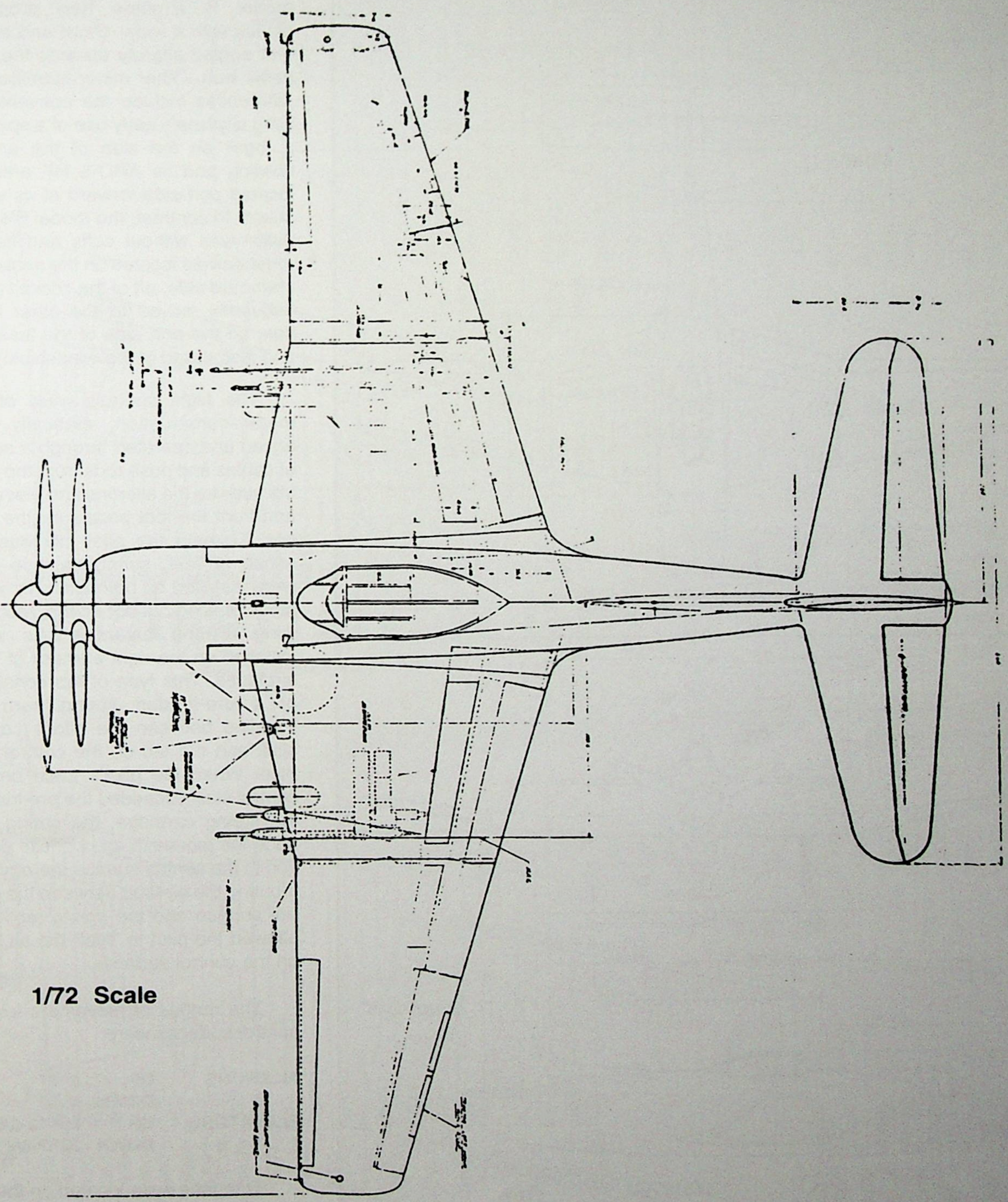
CONVENTIONAL MODEL A WING



1/72 Scale



CONVENTIONAL MODEL A WING ON XBTC-2 NUMBER ONE BuNo 31401



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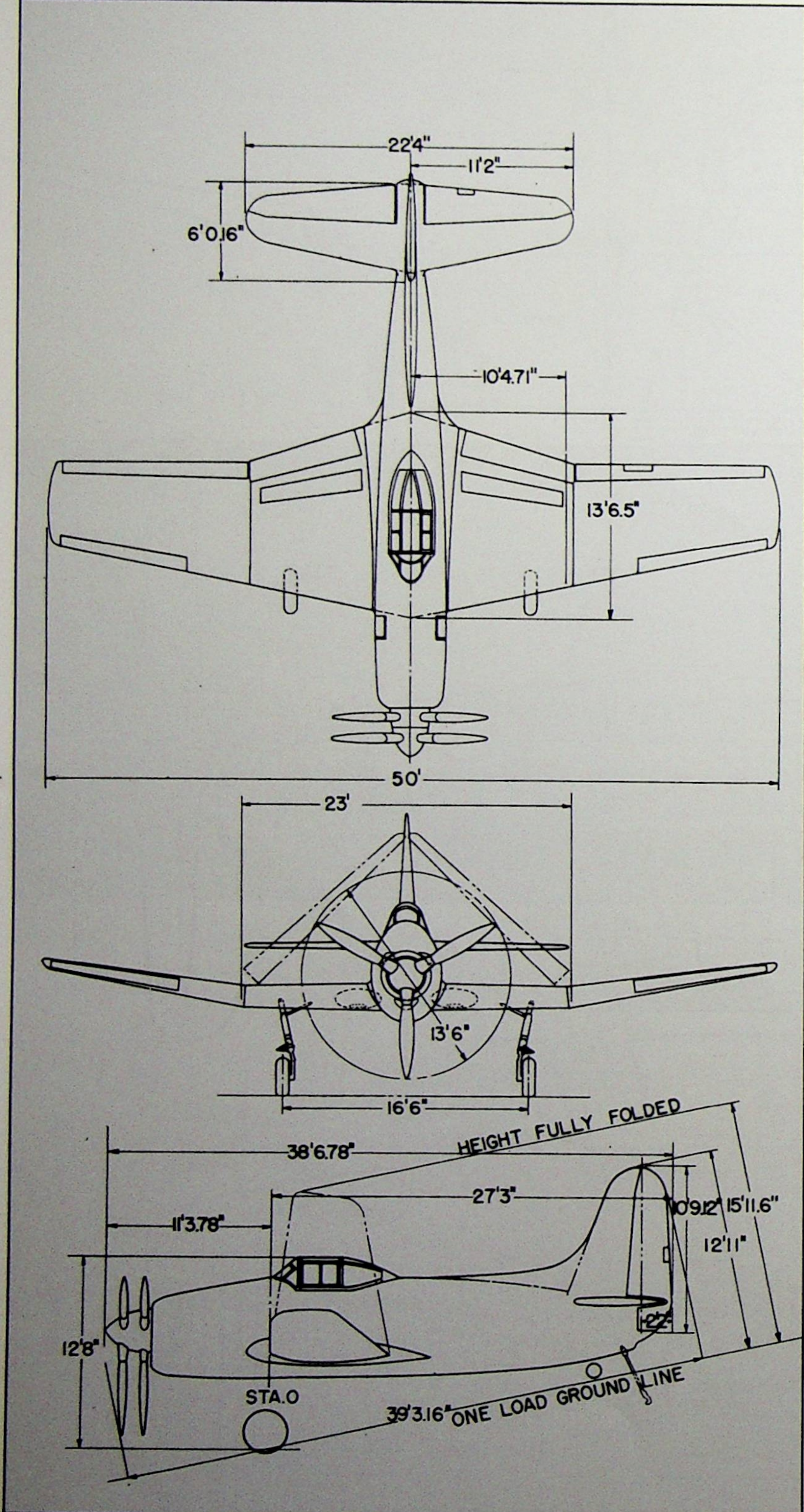
XBTC-2 WITH DUPLEX WING GENERAL ARRANGEMENT



decals and did utilize propeller cuffs. For the propeller vibration tests of 4 May 1945, the cuffs were removed revealing a narrow-chord propeller with a tapered base. By contrast the model B airplane had propeller blades with a wider chord and bases that angled sharply towards the propeller hub. Other minor identification differences include the conventional wing airplane's early use of a spinner, a logo[2] on the side of the engine cowling and its ARC-5 HF antenna located port-side forward of its windshield. In contrast, the model B's propeller was without cuffs and its HF antenna was located on the airplane's starboard side, aft of the cockpit (subsequently moved to the other location, on the port side of the fuselage and just ahead of the windshield).

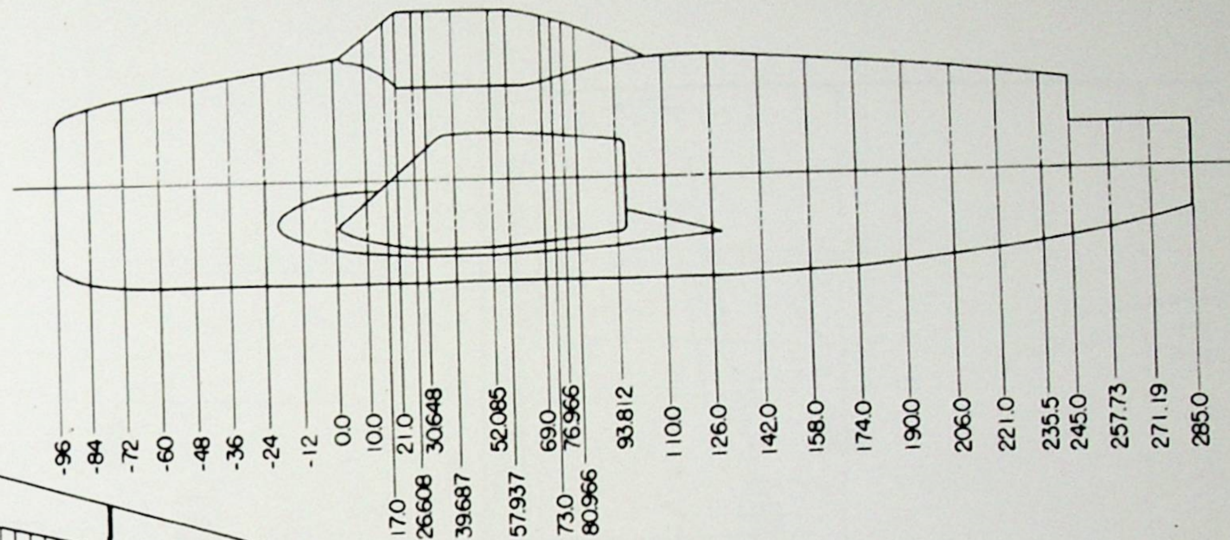
The flight controls were of all-metal construction, statically balanced and operated through a series of cables and push rods from the control stick for the ailerons and elevators and from the foot pedals for the rudder. To help the pilot increase his sense of feel, spring balance tabs were installed on both ailerons of the Model A wing but not on the Model B wing. Spring balance tabs were installed on the right elevator of both airplanes. This type of tab consisted of a pre-loaded spring cartridge installed between the pilot's control stick and the tab on the control surface. When the pilot's force on the control stick exceeded the pre-load of the spring cartridge, the spring balance tab moved in an opposite direction to the control surface thereby distributing the air-load between the control surface and the spring tab. This allowed the pilot to "feel" the air load on the control surfaces.

The ranges of movement for the control surfaces were:

AILERONS	**UP**	**5° 3"**
	DOWN	**5° 3"**
ELEVATORS	**UP**	**35° 12-5/8"**
	DOWN	**20° 7-3/8"**

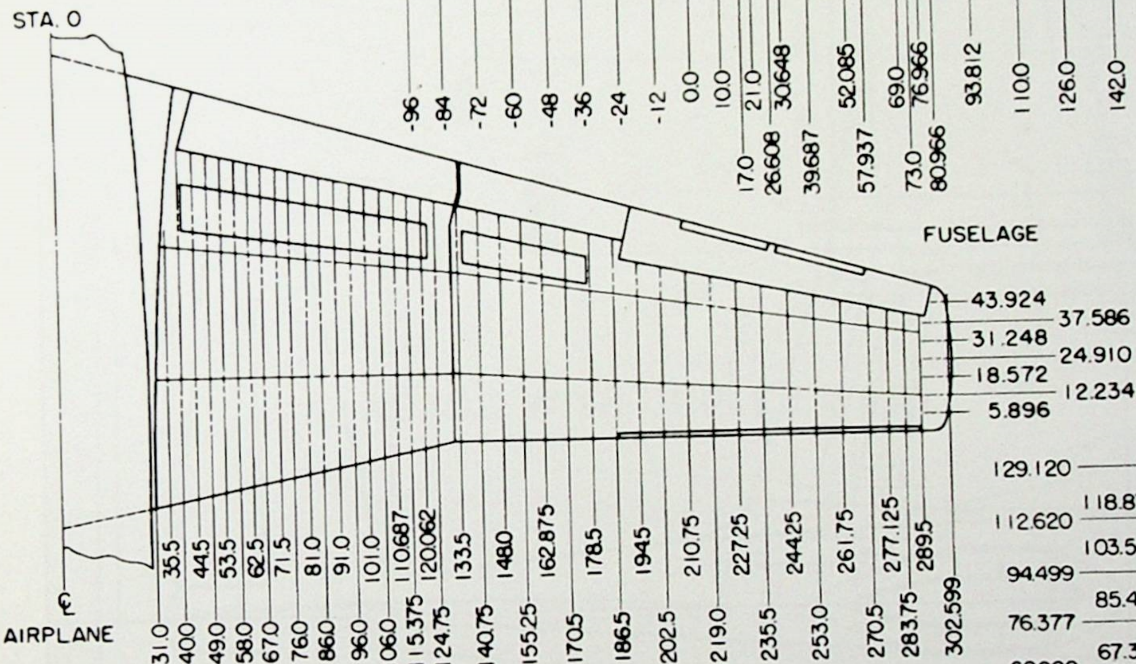
Trim tabs were located on the left aileron, left elevator and rudder. Each tab was provided with 20° of movement. The pilot's controls consisted of individual controls, grouped

XBTC-2 STATION DIAGRAMS

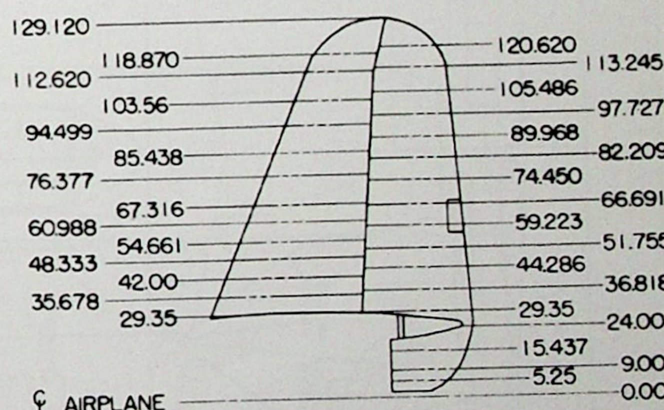


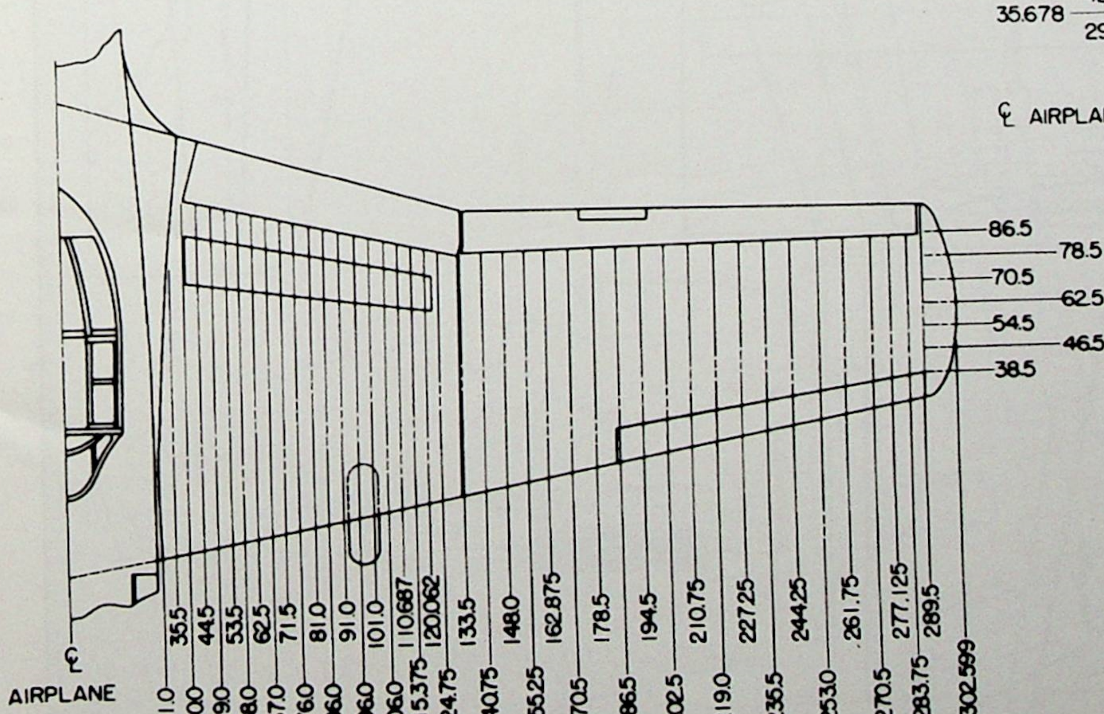
FUSELAGE

1/72 Scale

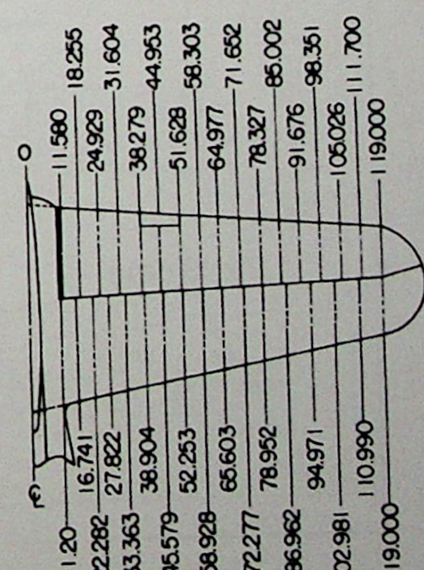


WING (CONVENTIONAL)



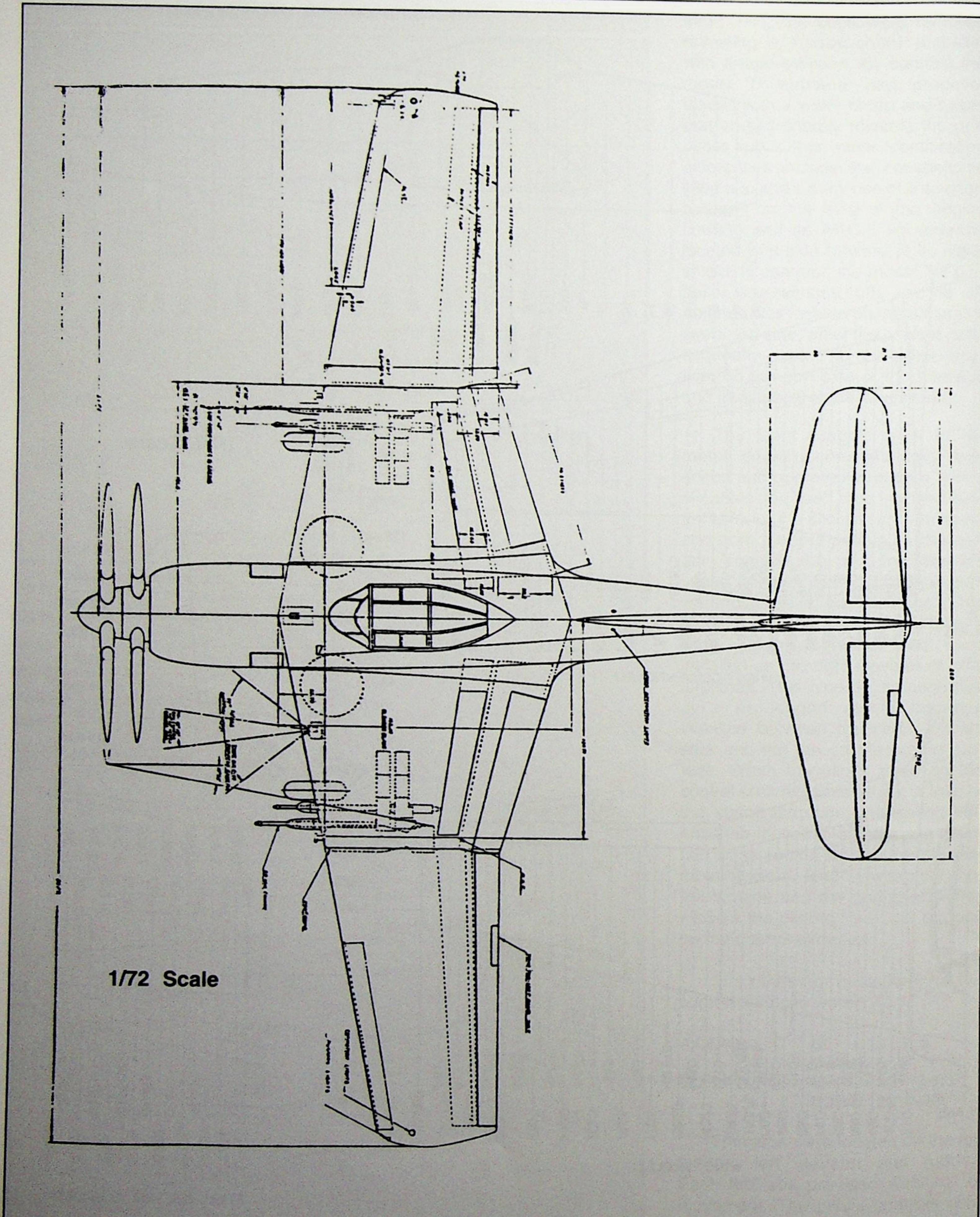


WING (DUPLEX)



STABILIZER AND ELEVATOR

DUPLEX MODEL B WING ON XBTC-2 NUMBER TWO BuNo 31402



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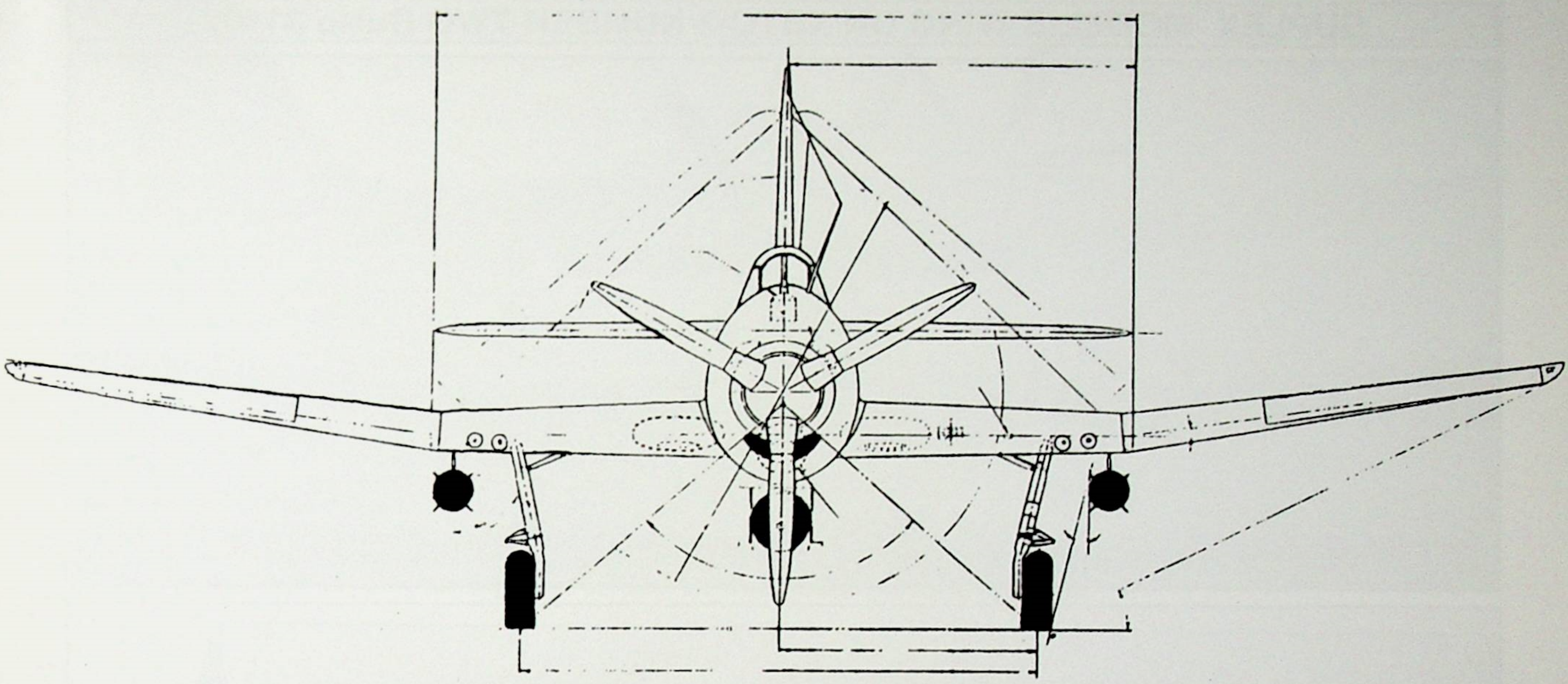
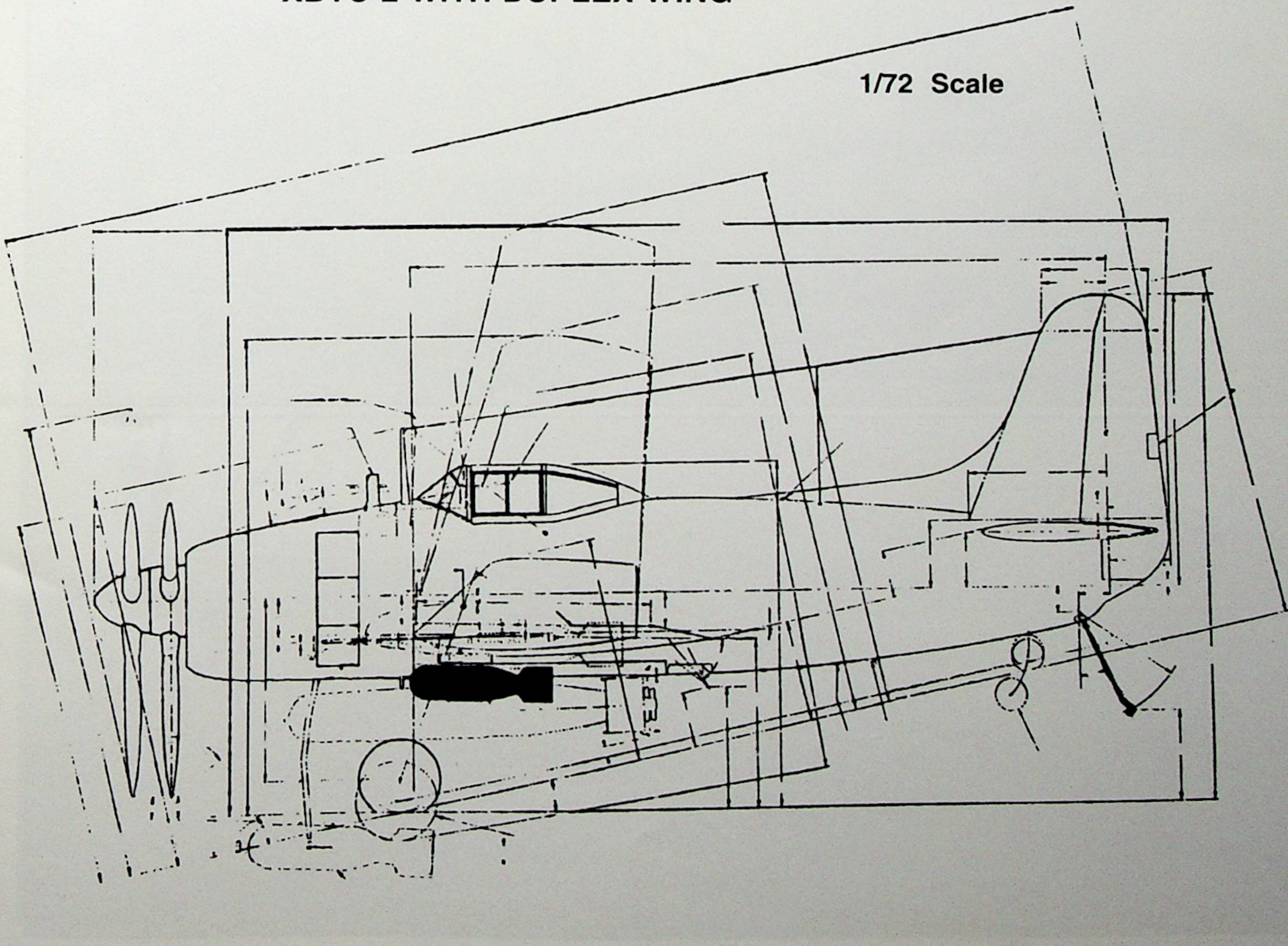
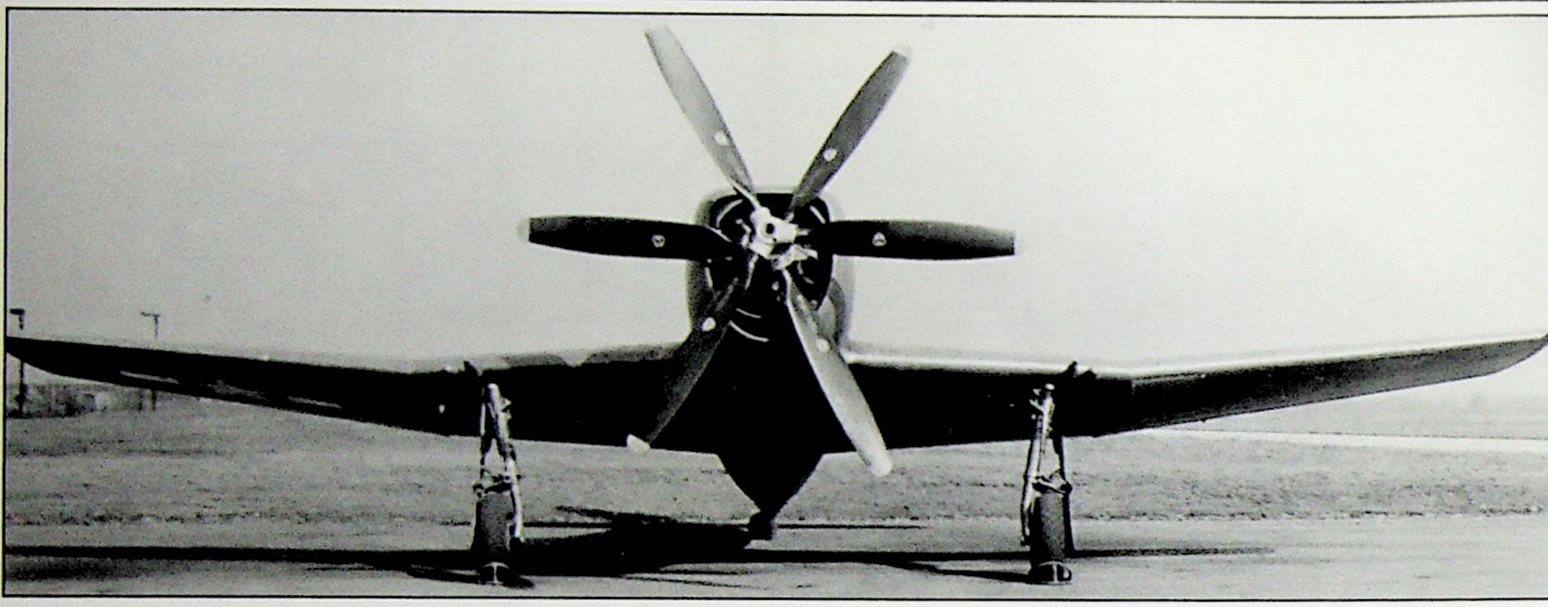


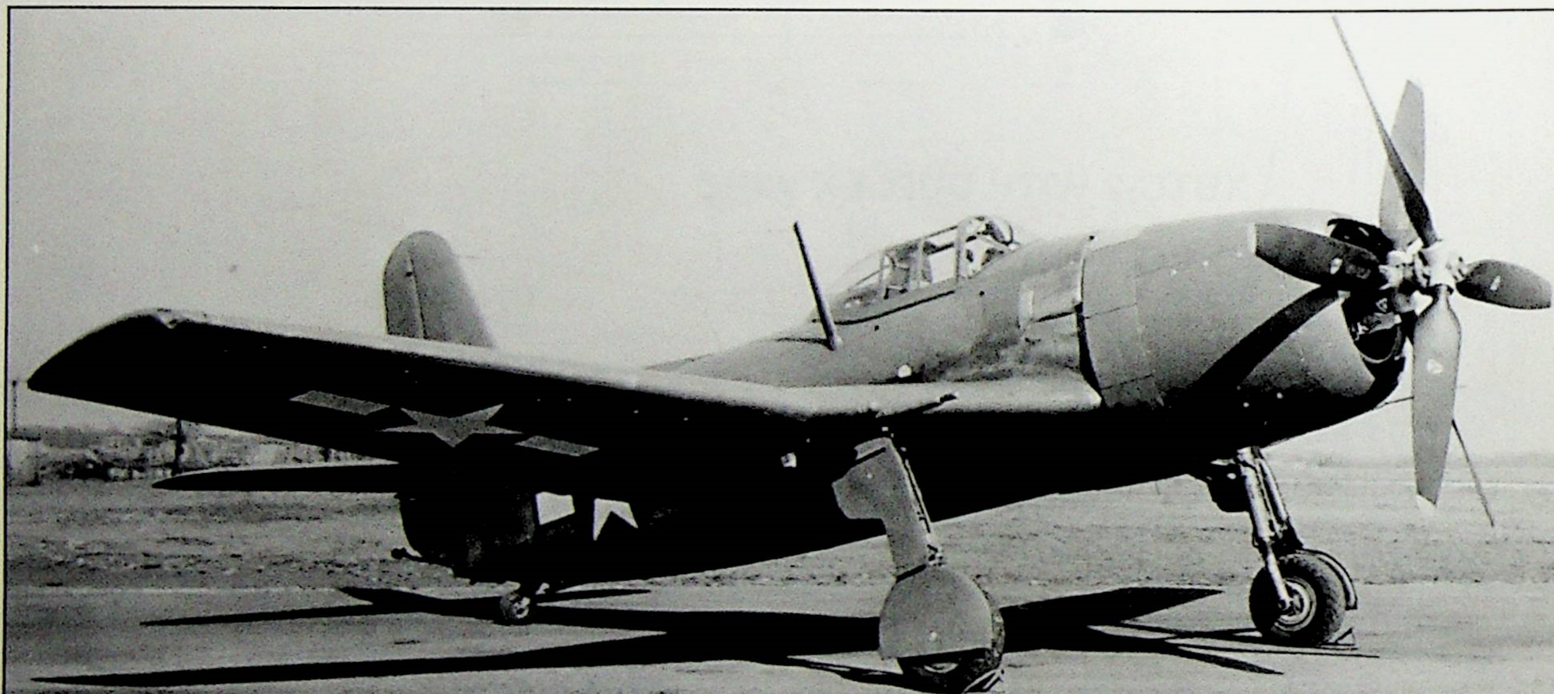
XBTC-2 WITH DUPLEX WING

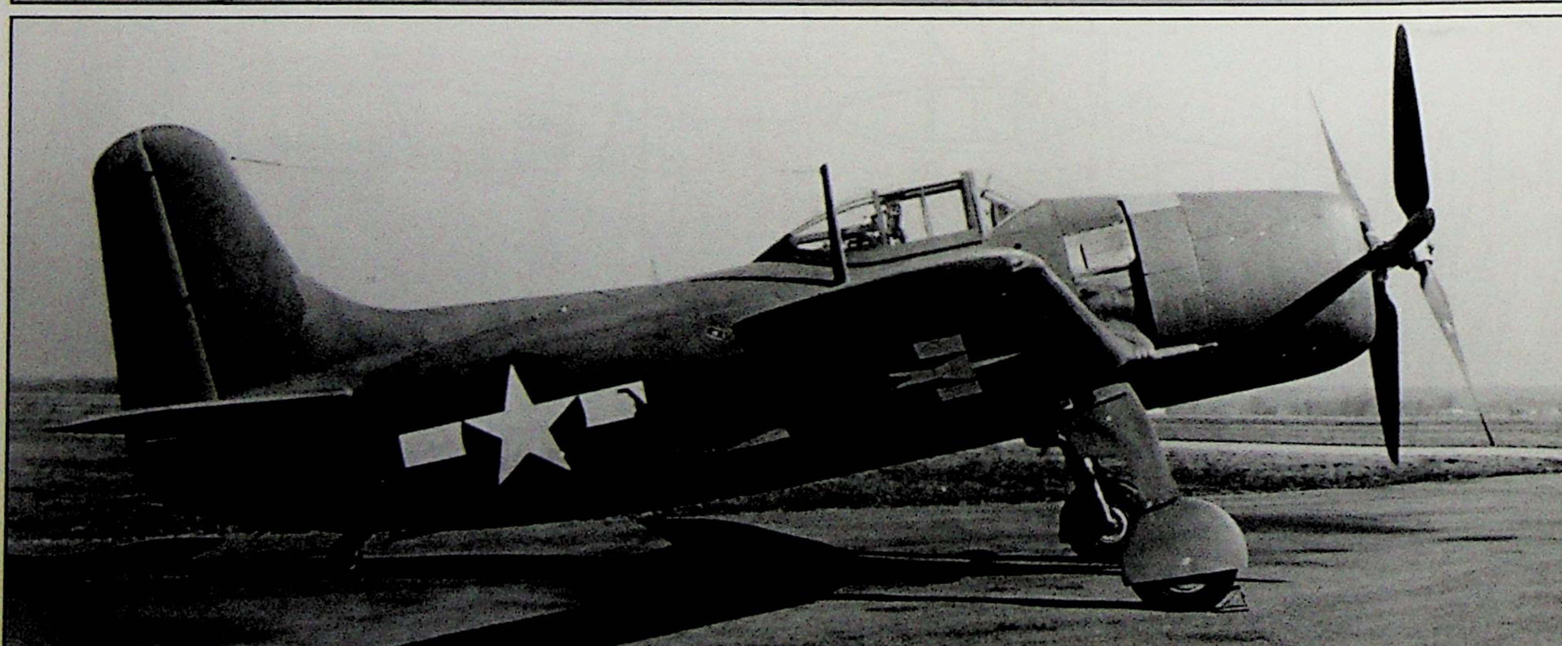
1/72 Scale

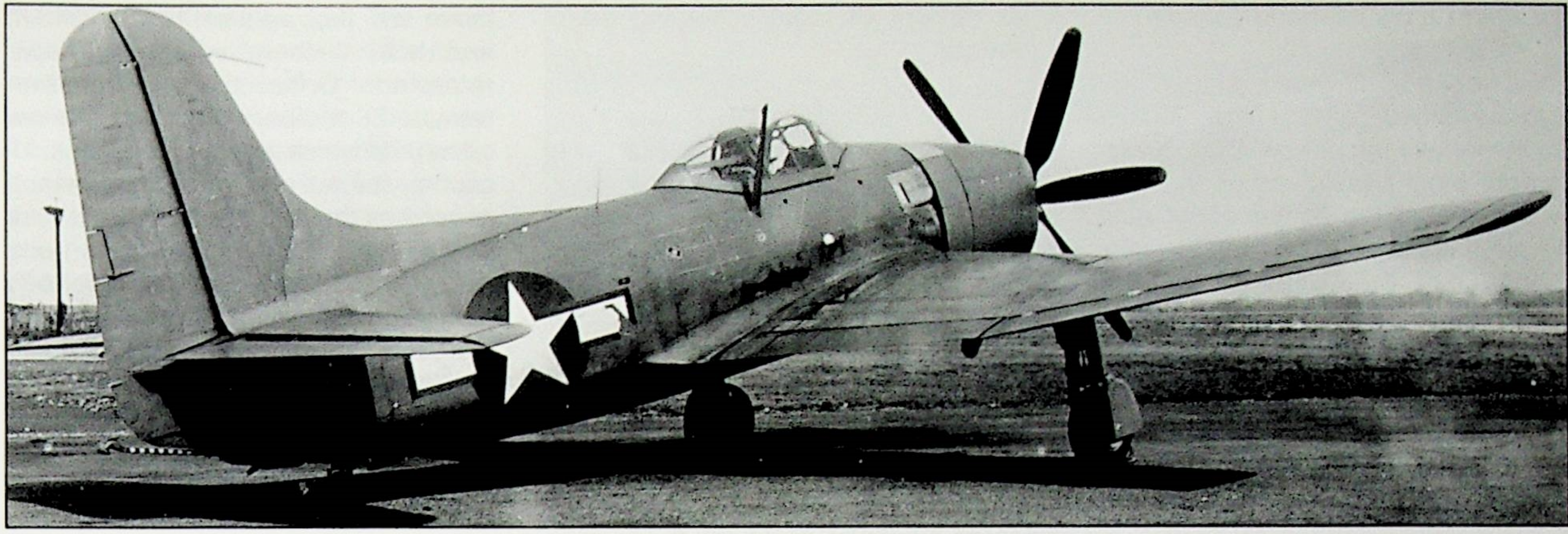


DUPLEX MODEL B WING ON XBTC-2 NUMBER TWO BuNo 31402

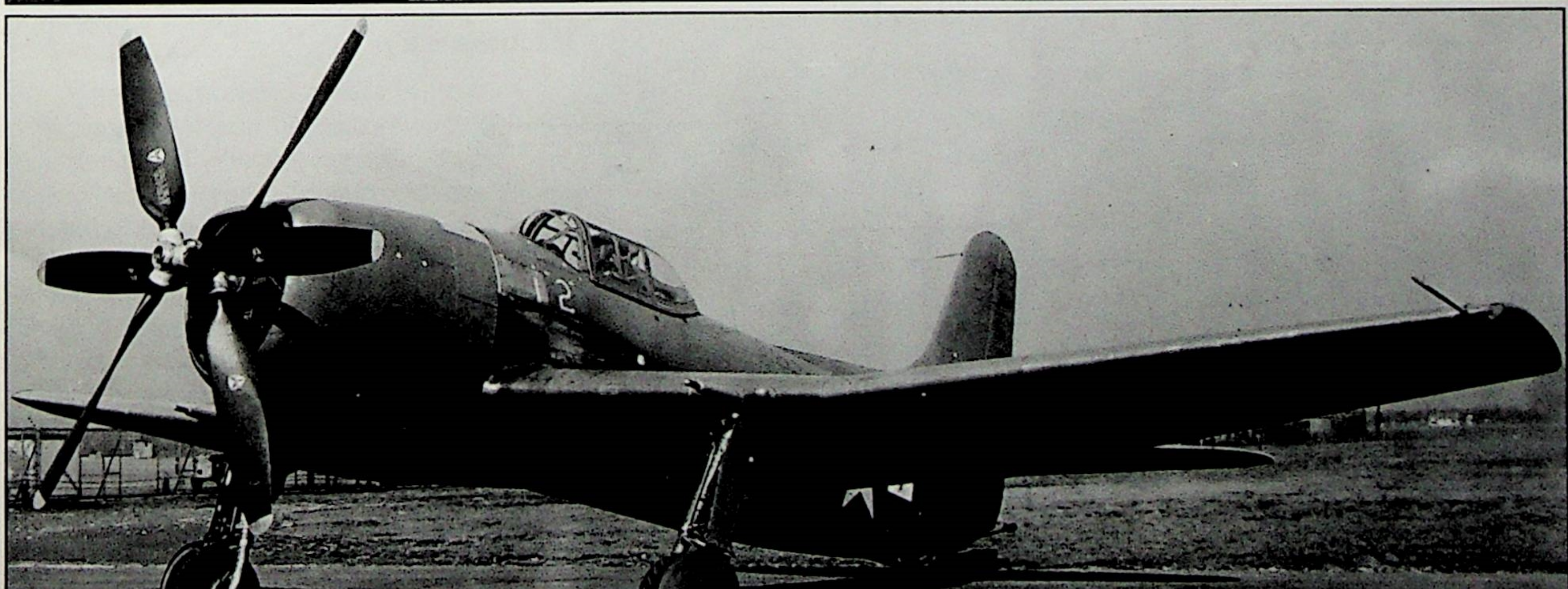








The number two ship BuNo 31402 with Duplex wings on 12 February 1946. The model B's propeller was without cuffs and its HF antenna was located on the airplane's starboard side, aft of the cockpit (subsequently moved to the other location, on the port side of the fuselage and just ahead of the windshield). Note shape of wing as seen by its shadow at left bottom. A hand-painted "2" was applied to the fuselage side beneath the windscreen. (National Archives)

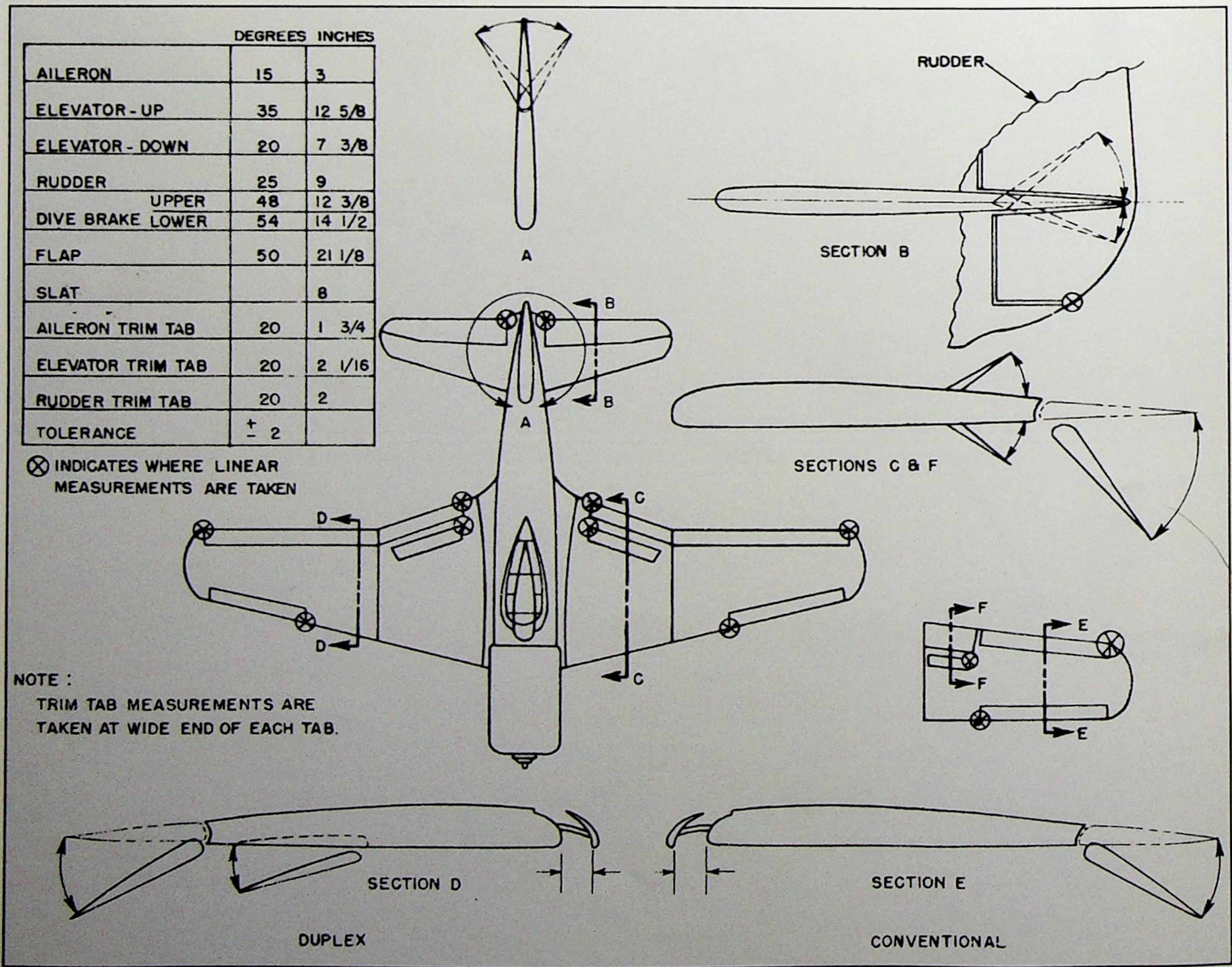


together on his left-hand console.

The XBTC-2 was equipped with hydraulically-operated flaps located on the inner wing panel's trailing edge of both wing models and on the outer wing panel of the conventional wing. These flaps were supported by a link mechanism that allowed them to move rearward before they started to deflect downwards. This rearward movement formed an air passage (slot) between the upper surface of the flap and the flap cavity in the wing panel, hence, slotted flaps. Additionally, leading edge slats were located on the outer wing panel of both wing models. These slats, when extended, created a similar air passage (slot) between the under surface of the slat and the upper surface of the wing. However, they were without the familiar "droop" of today's leading edge devices.

The slotted flaps and slats were sequentially-operated through the pilot's flap control located in the middle section of the left console to serve as take-off or landing flaps. To extend the landing flaps, the pilot would position his flap lever to its "EXTENDED" position and the slats would extend. Then, after a three-second pause the flaps would start their downward deflection. That 3-second pause was to give the pilot time to counter the nose-up pitching movement caused by the slat's extension. Once the flap angle indicator showed the desired flap deflection, with the maximum being 50°, the pilot would move the flap control to its "OFF" position. To raise the landing flaps, the pilot would move the flap control to "CLOSED" and hold it there while the flaps retracted. Once the flaps were retracted, another 3-second pause occurred, which in this case was to counter the nose-up pitching moment caused by the flap's retraction. At that time, the slats would retract. In both cases, the Extend and Close schedules required about 10 seconds to complete before the pilot could position the flap control to "OFF".

The Duplex flaps also were a slotted flap that was stowed on the underside of the wings, forward of the ailerons. The flap panels were attached to two sets of four arms. One set was used to extend the flaps into position below the ailerons so that the slot would be great enough to allow for an undisturbed flow of air to

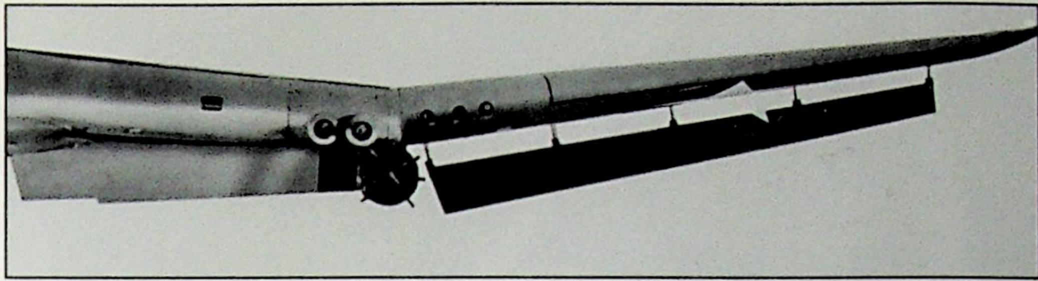


	DEGREES	INCHES
AILERON	15	3
ELEVATOR - UP	35	12 5/8
ELEVATOR - DOWN	20	7 3/8
RUDDER	25	9
DIVE BRAKE UPPER	48	12 3/8
DIVE BRAKE LOWER	54	14 1/2
FLAP	50	21 1/8
SLAT		8
AILERON TRIM TAB	20	1 3/4
ELEVATOR TRIM TAB	20	2 1/16
RUDDER TRIM TAB	20	2
TOLERANCE	± 2	

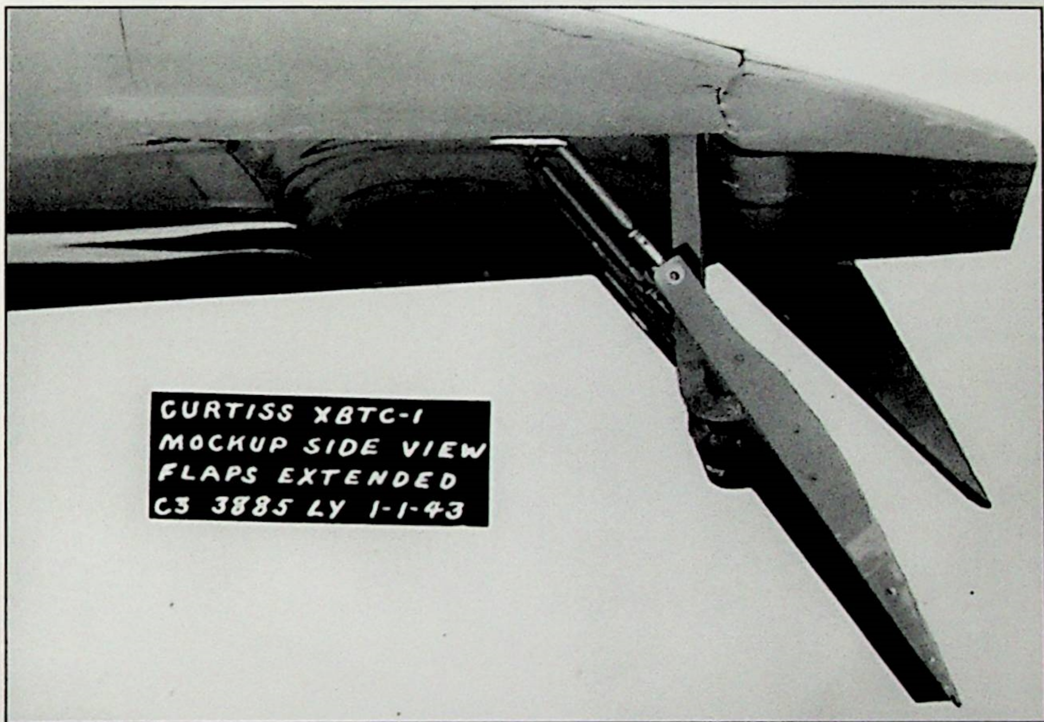
the bottom of the ailerons. The other set of arms served to deflect the flaps from their faired position to a maximum deflection of about 35° down. The duplex flaps were electrically operated through a switch located on the left-hand console that had three positions, "EXTEND", "OFF" and "RETRACT". This switch had to be returned to "OFF" after operation of the Duplex flaps to prevent the current drain from tripping the circuit breaker. A separate switch labeled "OVERRIDE" permitted retraction of the duplex flaps in the event an unsynchronized condition of greater than four degrees of angular travel existed.

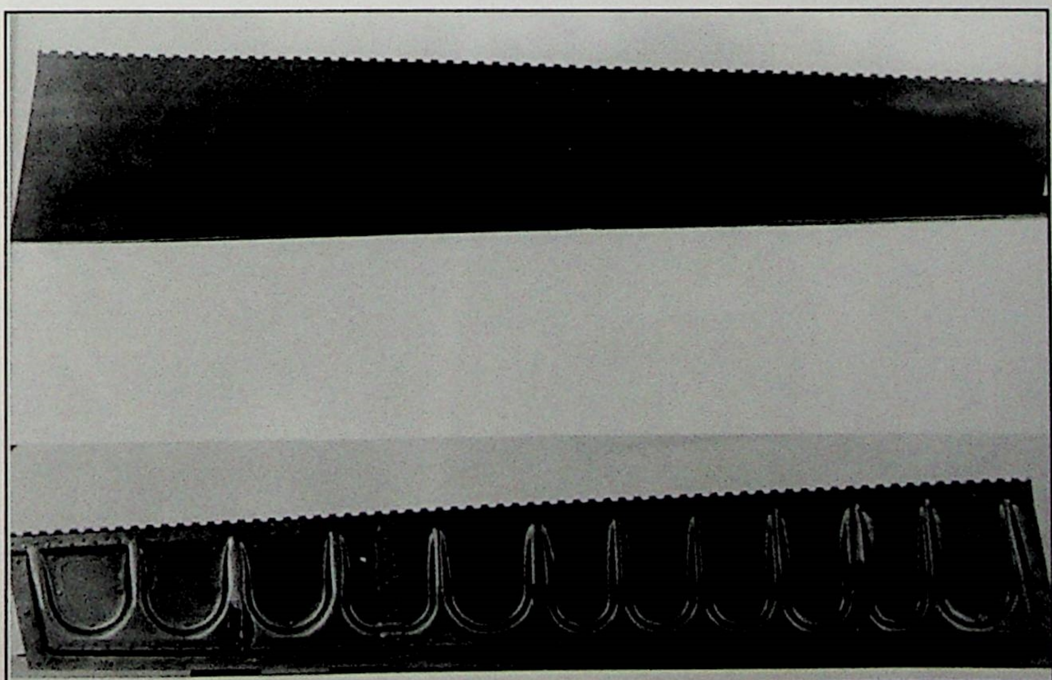
The dive brakes that were designed for use on the XBTC-2 consisted of rectangular flaps, hinged at their leading edge and located on the top and bottom surfaces of the inner wing panel just ahead of the landing flaps. On the Model A wing, an additional set of dive brake panels were similarly located on the outer wing panel. On the inner panel of both wing models, the lower dive brake panel was longer than the upper. The pilot's control was in the form of a three-position lever ("OPEN", "NEUTRAL" & "CLOSE") located forward on the left-hand console. The hydraulic power used to operate the dive brakes was provided by the secondary hydraulic system. On the two XBTC-2s that are the subject of this book, the dive brakes were rendered inoperative.[3]

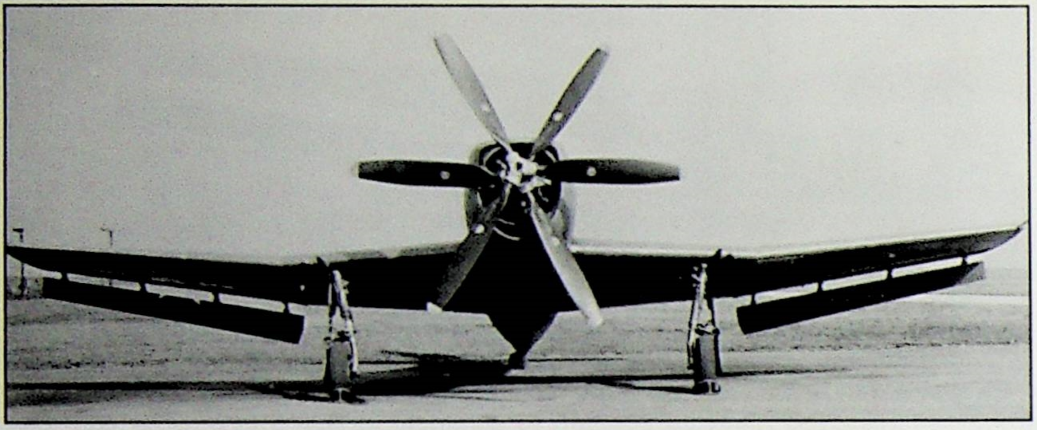
The R-4360 engine was in Pratt & Whitney's words "A four-row, 28-cylinder radial with the cylinders in a spiral arrangement...". Further, the similarly-numbered cylinders of each row were grouped together forming a "bank" (the same terminology as used when describing in-line engines) of cylinders. This resulted in a total of seven "banks". The angular offset of the cylinders in a bank, that is the "spiral arrangement", was created by first dividing 360 by 7 (the number of cylinders in a row) then dividing that result, 51.428571, by 4 (the number of cylinders in a bank). The resulting 12.857142 was the amount of angular offset between cylinders in a bank.



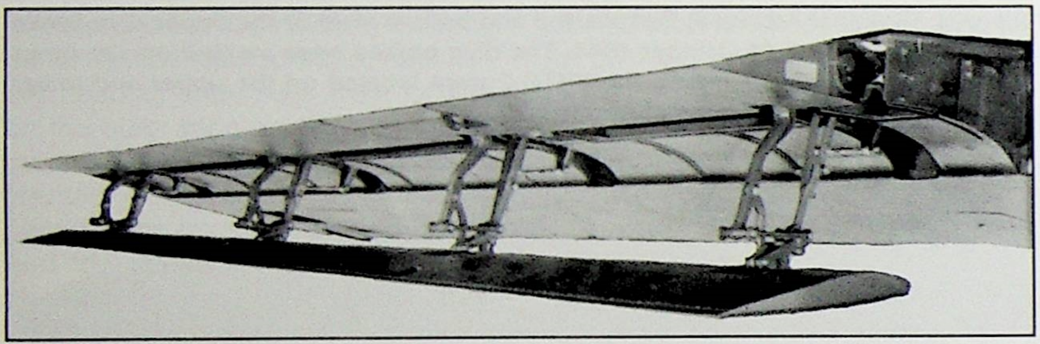
Above and below, XBTC-1 mock-up with duplex flaps (outer) and dive flaps (inner) extended. Below, original duplex flap extension mechanism differed significantly from that used on the actual aircraft. Note the flaps had to extend aft then down from their recessed retracted position to eliminate airflow interference with the ailerons. (National Archives) Bottom, top and bottom view of the upper dive brake from the XBTC-2 on 19 October 1944. The dive brakes were located on the inner wing panels. The dive flaps on the XBTC-2 were located on the upper and lower surfaces of the wings. (National Archives)

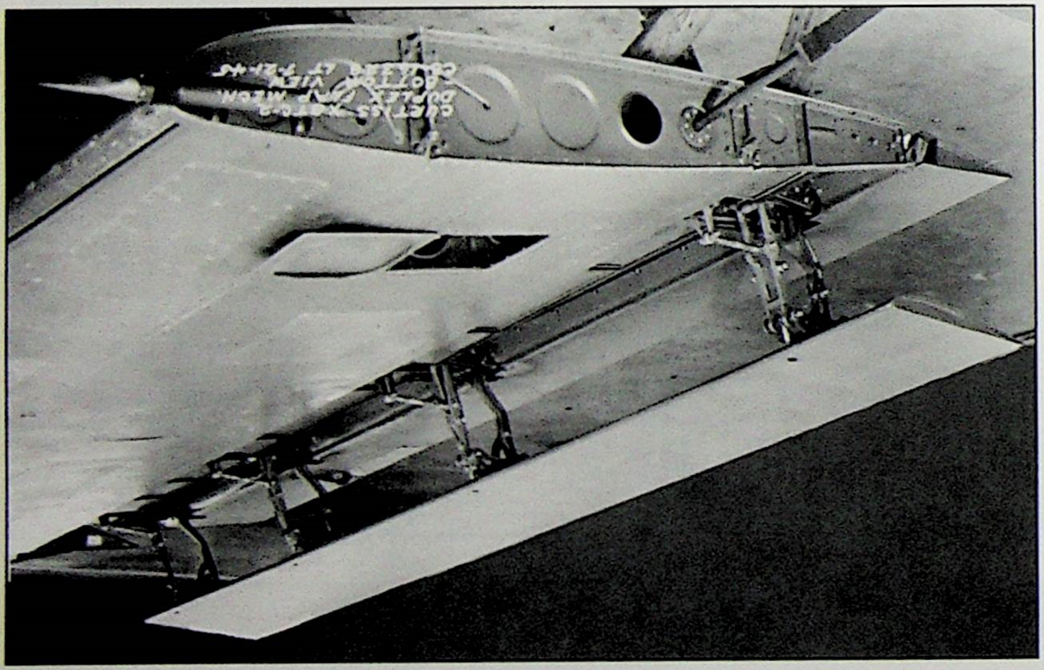






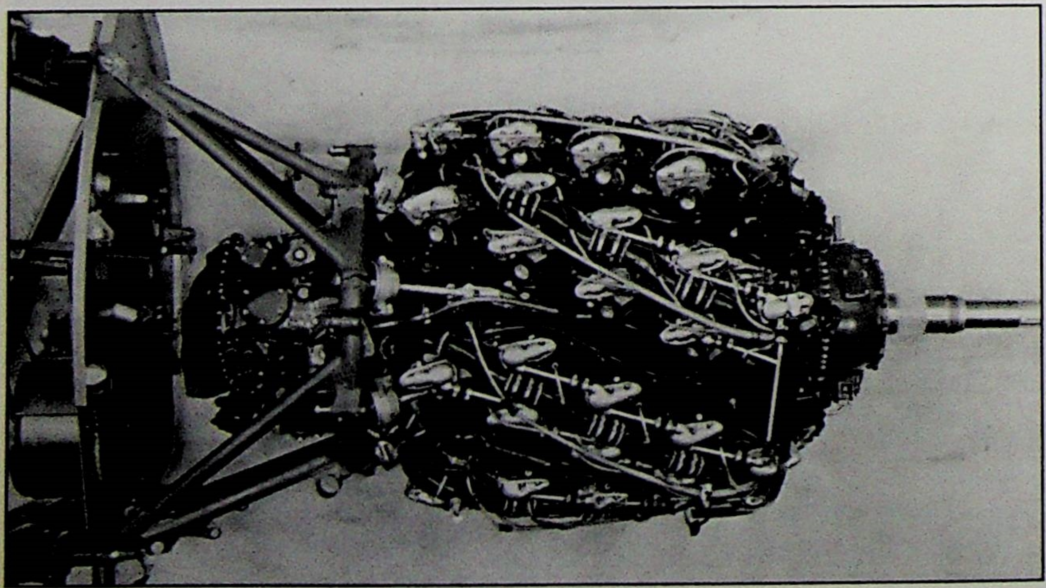
At left, duplex-winged XBTC-2 with flaps extended on 12 February 1946. (National Archives) Below left, rear view and front view of duplex flap mechanism in the extended position on 21 July 1945. (National Archives)





This "spiral" then ensured that each piston (through their connecting rods) would be moved up & down once in each 360° of crankshaft revolution. This spiral arrangement also provided Pratt & Whitney with the means to effectively cool their powerful four-row engine.

Normally, with radial engines the engines were cooled by a "straight-through" method of airflow. In this method, the cooling air flowed straight from its entrance at the cowling, past the cylinder heads which were aligned with their intake and exhaust valves perpendicular to the cooling air flow, until the now heated cooling air exited through the end of the cowling. On the R-4360 however. the cylinders were cooled by a "cross-cylinder" airflow. This was accomplished within that previously described spiral arrangement by rotating the cylinder heads about 75° clockwise. This arrangement, aided by the use of baffles, effectively put the hottest part of a cylinder head, its exhaust valve, almost directly into the path of the cooling air. This technique resulted in the cooling air flowing from the exhaust valve across the face of the cylinder to its intake valve, the cross-cylinder airflow. Another cylinder-cooling technique was the use of a greater number of cooling fins on the R-4360 cylinder heads. By comparing a cylinder head from say the P&W R-2800 with one from the R-4360, you'll notice that the R-4360's cooling fins were thinner, and consequentially, more numerous. The R-4360's cooling fins additionally had a

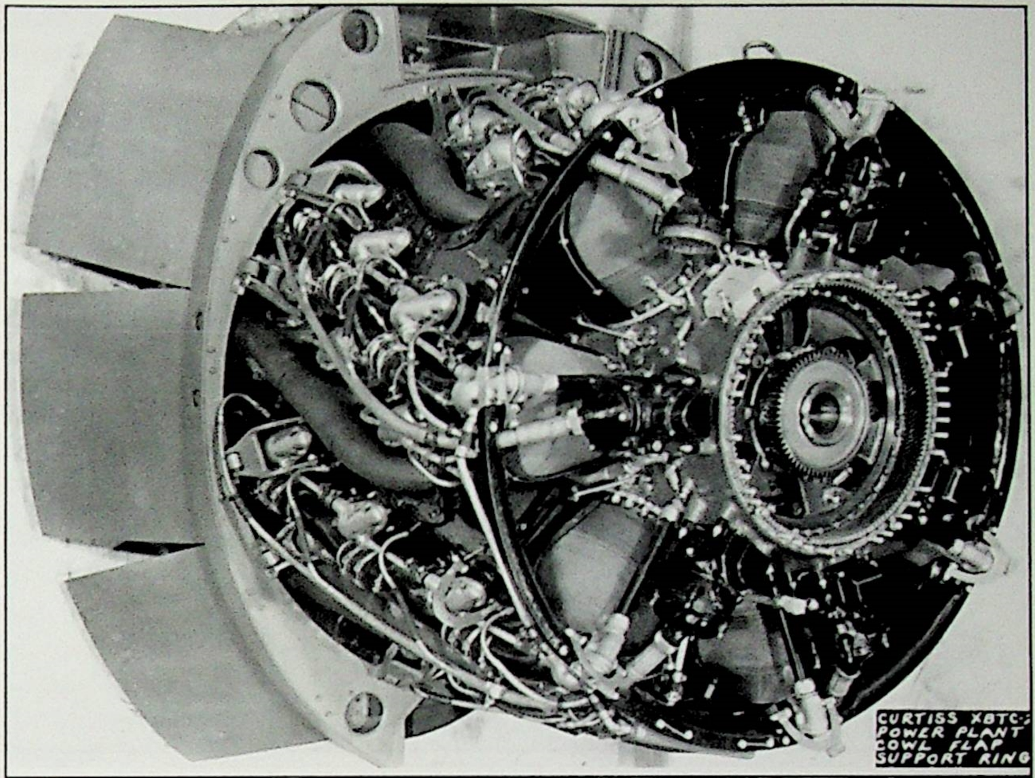


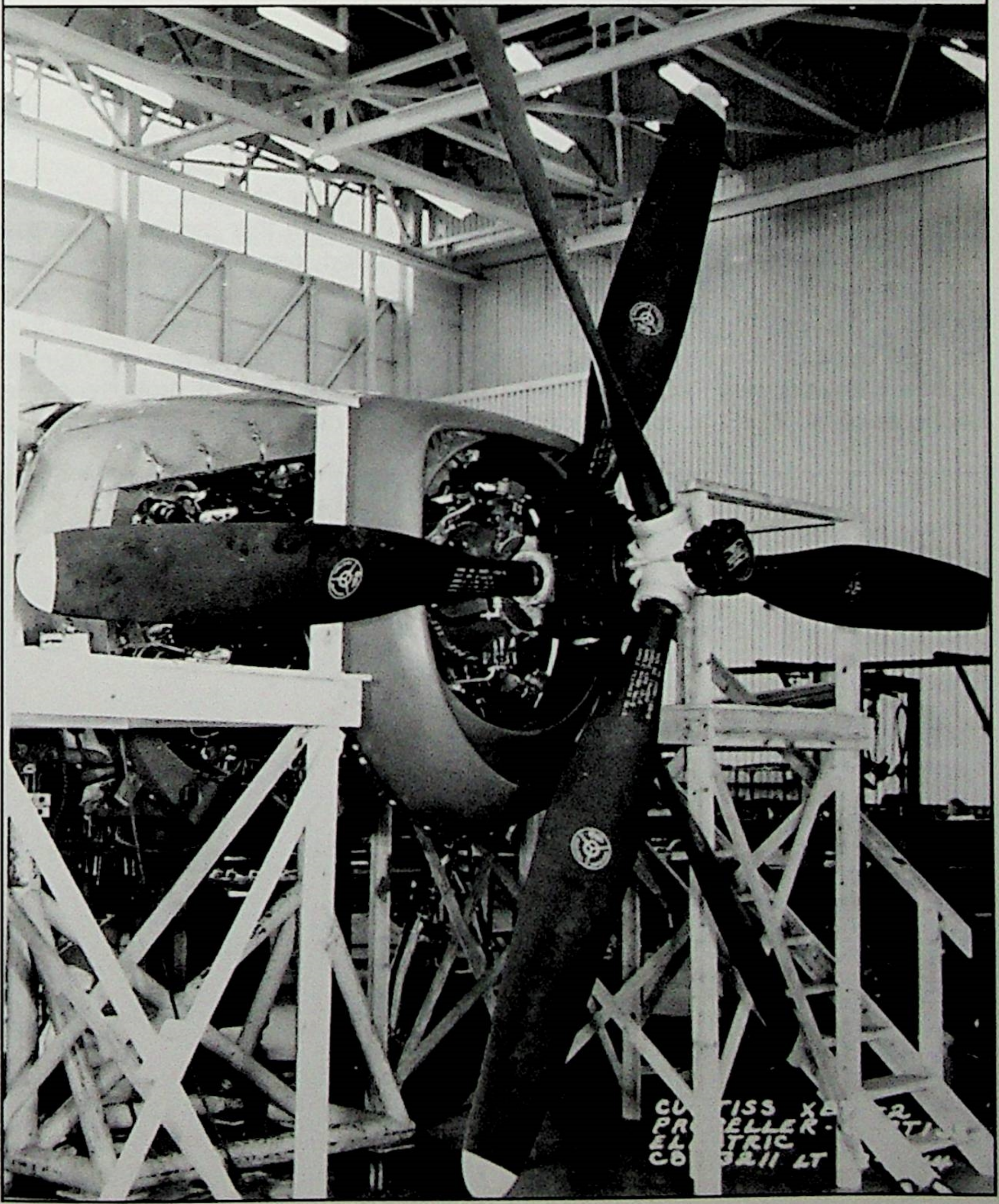
At left, R-4360 attached to its engine mounts before adding accessories on 19 October 1944. (National Archives)

greater depth which when combined with their greater number, added up to an increase in the total amount of cooling fin area per cylinder head.

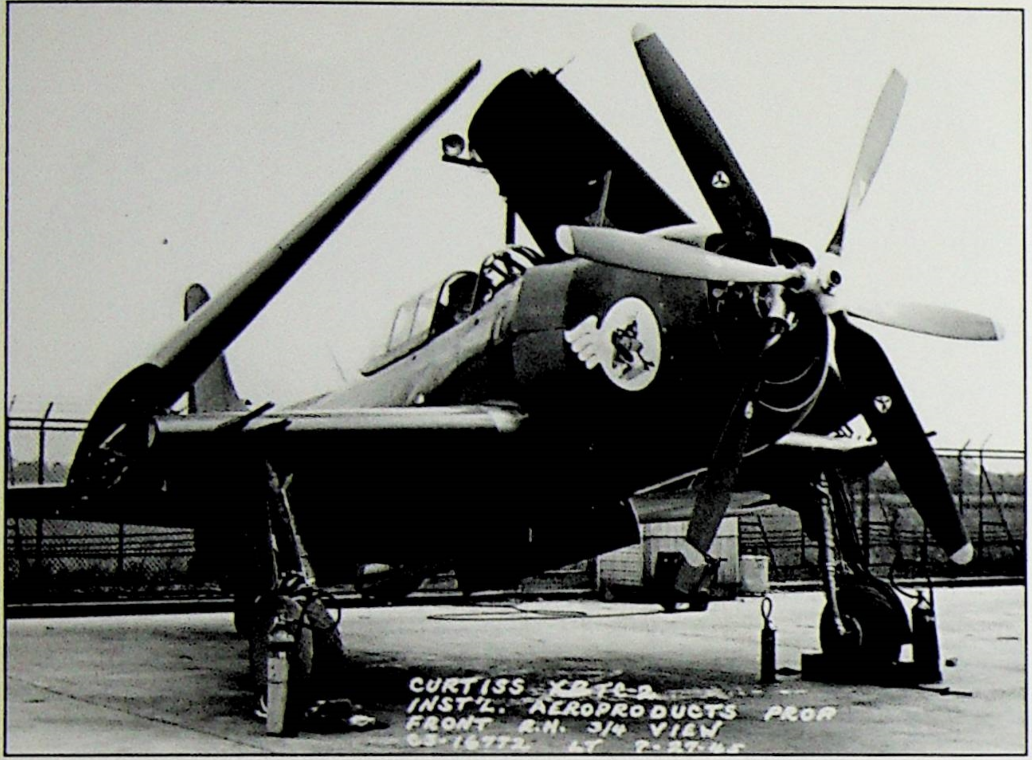
The use of a contra-rotating propeller promised several advantages for the XBTC-2. The first of these from the viewpoint of our carrier-based pilot was that the contra-rotating propeller provided a counter to the torque effect that plagued the high-power, single-engine airplanes of this era. This torque effect was created by the swirl from a single direction-of-rotation propeller that, at those combinations of high engine power and low airspeed such as found during a wave-off, change the direction of airflow at the vertical tail enough to make the airplane's rudder ineffective. The resulting loss of rudder control would cause the airplane to roll opposite the direction of propeller rotation, thereby performing the infamous "torque roll".

Another desirable feature of the contra-rotating propeller was that it did recover energy lost due to the swirling motion of the air in the propeller slipstream. This meant that now, the additional blades of a contra-rotating propeller would allow the R-4360's greater horsepower to be absorbed (converted to thrust) without the need for the propeller blades to be too long for use during arrested landings. For an explanation of "too long", as the tail-wheeled airplane approaches the end of its arrested roll-out, the arresting forces create a snubbing action which raises the airplanes tail thereby lowering the airplanes nose and propeller towards the flight deck. This "tail rise" condition would have been quantified in the aircraft's carrier suitability trials. For example, the Curtiss XBT2C-1 was required to meet a maximum allowable tail rise of 9' 2".



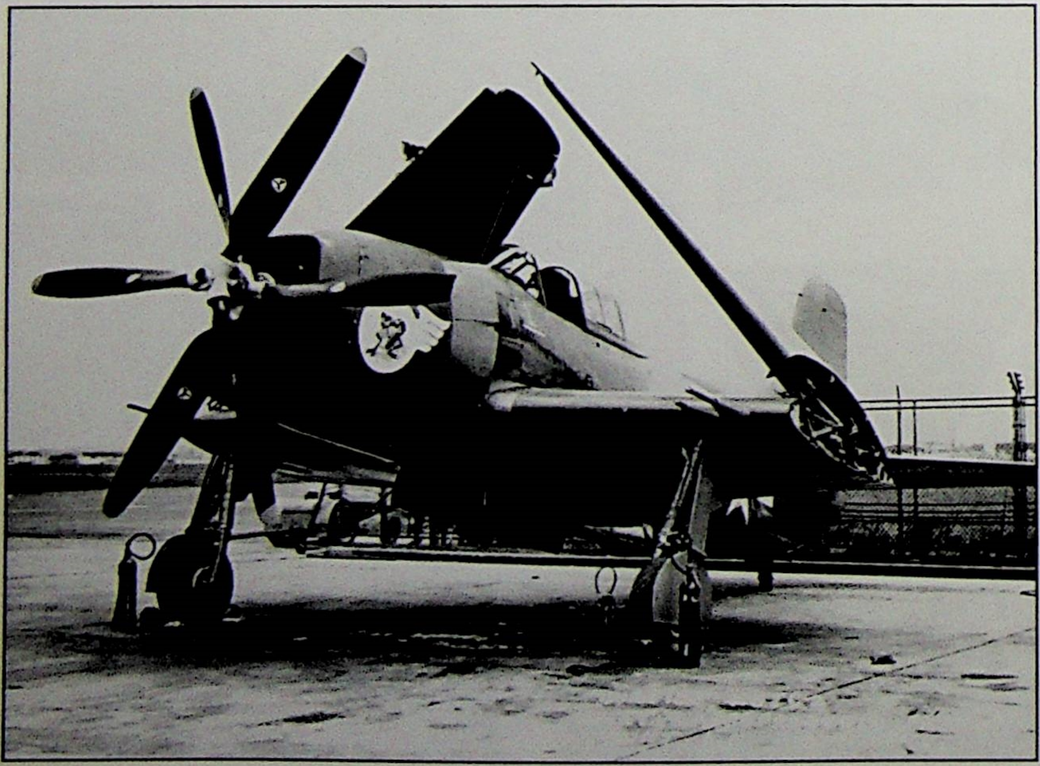


At top right, XBTC-2 powerplant with cowl flap and support ring attached on 20 October 1944. (National Archives) At right, XBTC-2 engine and propeller installed in December 1944. The propeller used here was a Curtiss Electric product. (National Archives)



Above and below, XBTC-2 ship number one with Aeroproducts propeller on 27 July 1945. (National Archives)

The propeller specified for the XBTC-2 was a Curtiss Electric[4] contra-rotating propeller and is perhaps the one depicted on an un-dated set of three-view drawings where it has a diameter of 14' 2". It can be first identified in the photo dated December 1944 by the Curtiss Wright decals on all six propeller blades. There, the photo also reveals that the propeller blades had a narrow chord with a gradual taper towards the propeller hub. Because this propeller was the designated one, it's probably also installed on BuNo 34101 as pictured on 28 April 1945. Referring to that photo, notice the addition of propeller cuffs but the lack of propeller-blade decals. Subsequently, by the time of the vibration tests on 4 May 1945, the propeller cuffs have been removed. At some point after the vibration tests (and landing accident), stress surveys revealed problems with the Curtiss Electric contra-rotating propeller and a change-over to an Aeroproducts[5] model AD7562 contra-rotating propeller was made. This propeller had a diameter of 13' 6" and is first seen installed in photos dated 12 February 1946. Quick identification features that set it apart from the Curtiss Electric propeller include a set of Aeroproducts decals on each blade and propeller blades with a broader chord that angles sharply into its propeller hub. I could not locate any photos of the Aeroproducts propeller with cuffs installed so its broader chord and base can be used as an identification feature.



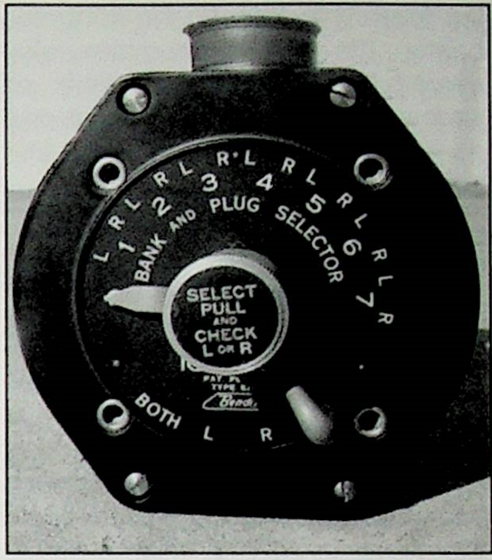
Another side effect of using contra-rotating propellers was the centerline alignment of the XBTC-2's vertical fin. Single-engined, carrier-based airplanes powered by a single plane-of-rotation propeller normally either had their vertical fins offset 3° to port or called for the use of 3° to 5° right rudder trim for take-off. These techniques were used to minimize the torque effect during take-offs and wave-offs. But as the old saying goes, "there is no free lunch in life" and the contra-rotating propeller brought along with it the problems of added weight caused by the additional set of blades and the complexity (and weight) of the dual-rotation propeller gearing.

Amongst those complexities was the need for two concentric propeller shafts, a longer, inner shaft which turned the forward propeller and a shorter, outer shaft for the rearward propeller. Propellers are attached to the engine's propeller shaft by a series of longitudinal splines that need to be strong enough to harness the rated horsepower developed by a particular engine. For example, an engine developing 3,500 HP or more would need a propeller shaft with SAE #60 spline. Our R-4360 models were provided with an SAE #60 spline for the inner shaft and an SAE #70 spline for their outer.

Before we leave this subject of propellers, it might be appropriate to make another comparison with the Mauler. Because the Mauler used a single plane-of-rotation propeller it used a different model of the R-4360, the -4. That difference in engine models was due to the need for reduction gearing that matched their types of propellers. Perhaps noteworthy also is the fact that the Mauler used a four-bladed propeller of 14' 8" diameter to handle its 3000 HP and a large, broad-chord rudder to aerodynamically minimize the slip-stream's swirl effect.

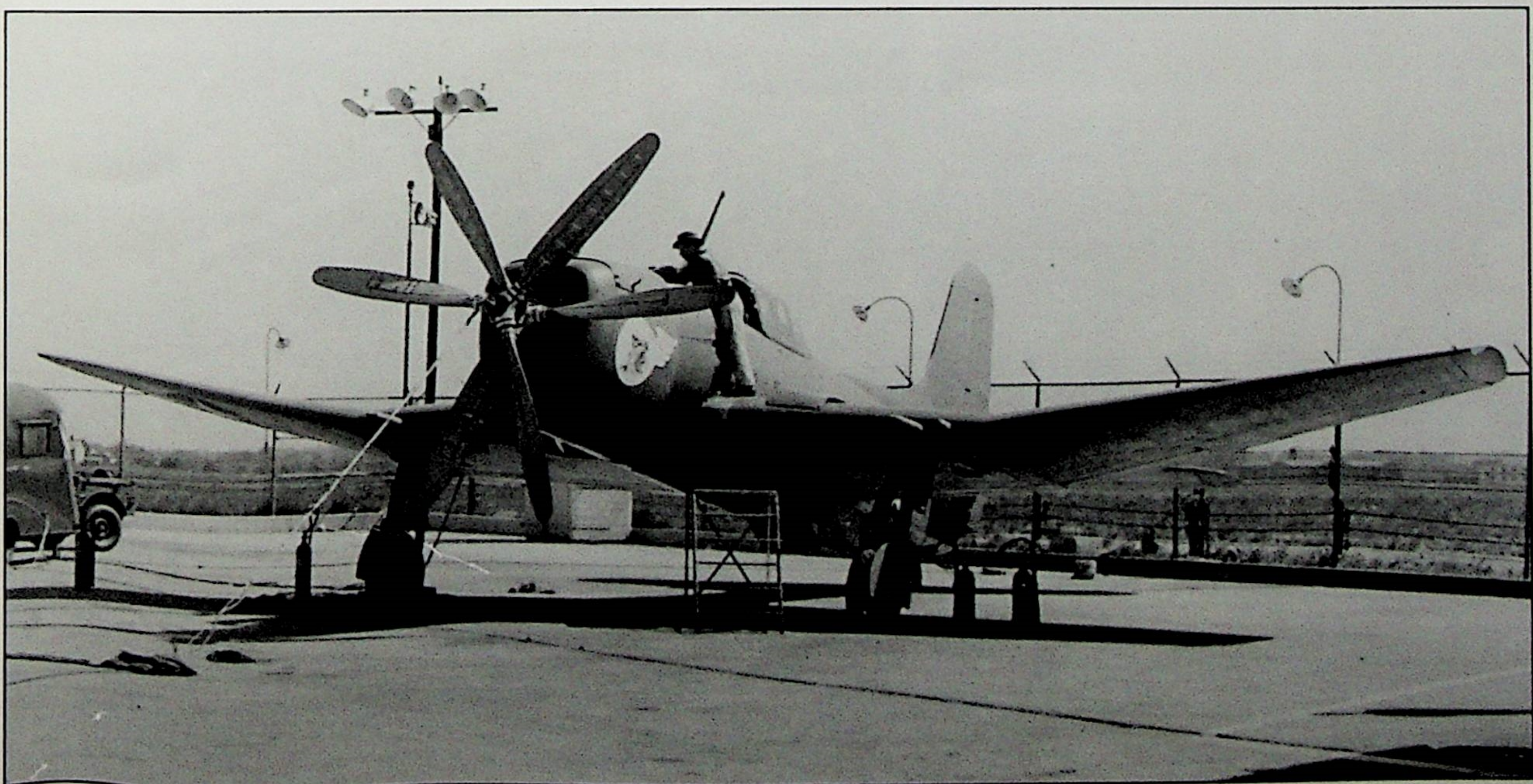
The ignition system for all the early models of the R-4360, including our models -8a & -14, was provided by seven Bendix D-4RN-2 high-tension, dual magnetos. Each magneto provided the eight spark plugs of its bank with 20,000 volts. The use of seven magnetos offered continued reliability of the engine should enemy action render one or two of the magnetos inoperative, but its high-tension capability was subject to shorting out (crossfire within the magneto) at high altitudes. Each magneto was located on the magneto drive case, in front of a cylinder of the front row (Row D). The pilot's control of this ignition system was, at first glance, his usual main magneto switch located on the Engine Switch panel to the lower left of the main instrument panel. Keeping with normal practice, the main ignition switch had a rotary paddle- shaped selector that was used to select the "BOTH", "LEFT", "RIGHT" or "OFF" position of its magnetos as marked on the bottom of its face. But the magneto switch now included a seven position bank and plug selector across its top. The bank and plug selector was a device for cutting out either the left or right set of spark plugs in any one bank of four cylinders. (A bank being the four, spirally arranged, similarly-numbered cylinders of each row.) The selector control was centered on the same axis as the mag switch and needed to be pulled out to select the bank of spark plugs served by one of the seven magnetos.

Before we go any further with this attempt to explain the magneto switch, the relevance of which will become apparent when our pilot checks "his mags", we'll offer our explanation of the cylinder designation system. This numbering system starts at the rear row and looking forward. The top cylinder of the rear row was designated as the No.1 cylinder. Proceeding clockwise, the next cylinder was the No. 2, then No.3,, etc on to cylinder No. 7. The four rows were designated alphabetically starting with the rear row as Row A and mov-



Above, unique seven magneto switch used on the XBTC-2s R-4360.

Below, Aeroproducts propeller rigged for vibration tests on 9 May 1945. (NMNA)



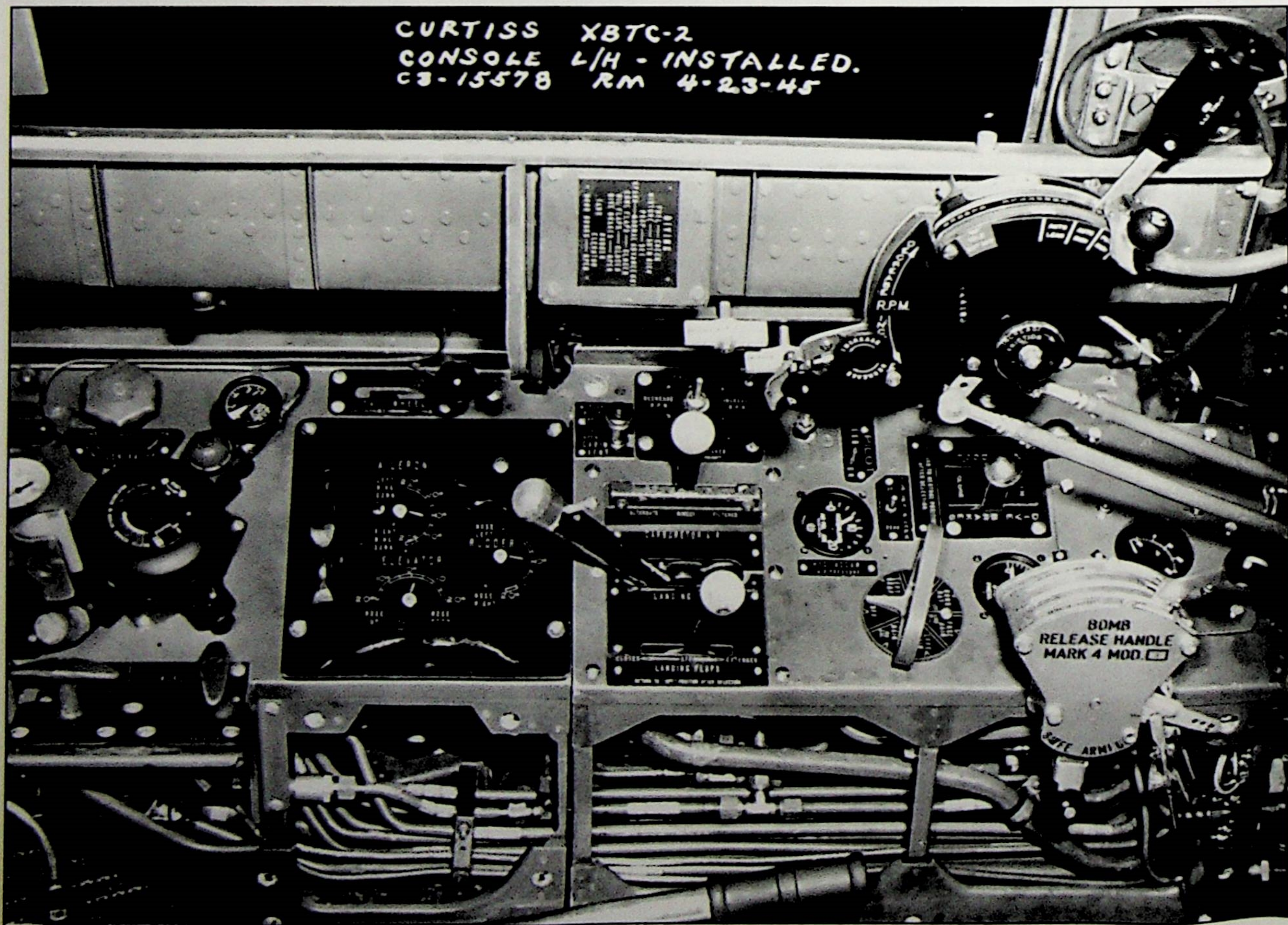
ing forward to Row D, the front row. Lastly, the cylinder numbers also served to designate their bank as such was displayed on the bank and plug selector portion of the magnet switch.

In normal operating practice, the magneto check would have been conducted by the pilot's setting the throttle at 30" HG (really field barometric pressure) and then he would switch the magneto from "Both" to "Right", check for a normal drop-off of less than 100 RPM, and then switch back to "Both". Then he would repeat the check using the "Left" magneto switch and look for a maximum difference in drop-off between the previous "Right" and "Left" magneto readings of 40 rpm. If an excessive rpm drop had been observed then either the "Left" or "Right" spark plugs of the suspect bank could be checked. This check would start with the main ignition switch on "Both" then "...lift up on the knob on the ignition switch axis and rotate the plug selector to the number corresponding to the set of plugs, left or right, that are to be cut out." At this point the Martin AM-1's Pilot's Handbook offers this "gem" of comfort to our intrepid aviator as he prepares to launch by stating, "Then turn the main ignition switch to "Left" or "Right". Little or no drop in RPM should be observed but the engine will be rough and the exhaust will pop if the plugs fail."

In keeping with the prevailing practice, the primary controls for the engine were installed on the engine control unit (aka power quadrant) located above the Left-Hand Console. Here, the throttle and mixture control were located on the top of the control unit and when moved forward, the throttle would increase power while the mixture control would enrich the fuel/air mixture. The propeller control lever along with its control wheel was located on the engine control units aft side. The full "INC RPM" position was located at the bottom of the propeller governor control lever's travel so the prop control lever was moved upwards to decrease the engine's RPM and downwards to increase it. (This direction of travel seems to be the opposite of what the pilot would have expected). After setting the desired RPM with the control lever, the control wheel would be used to fine tune the control lever's setting to the pilot's desired RPM.

Seemingly missing from the

Below, pilot's left-hand console with power quadrant mounted above it on the fuselage side below the canopy rail. (National Archives)

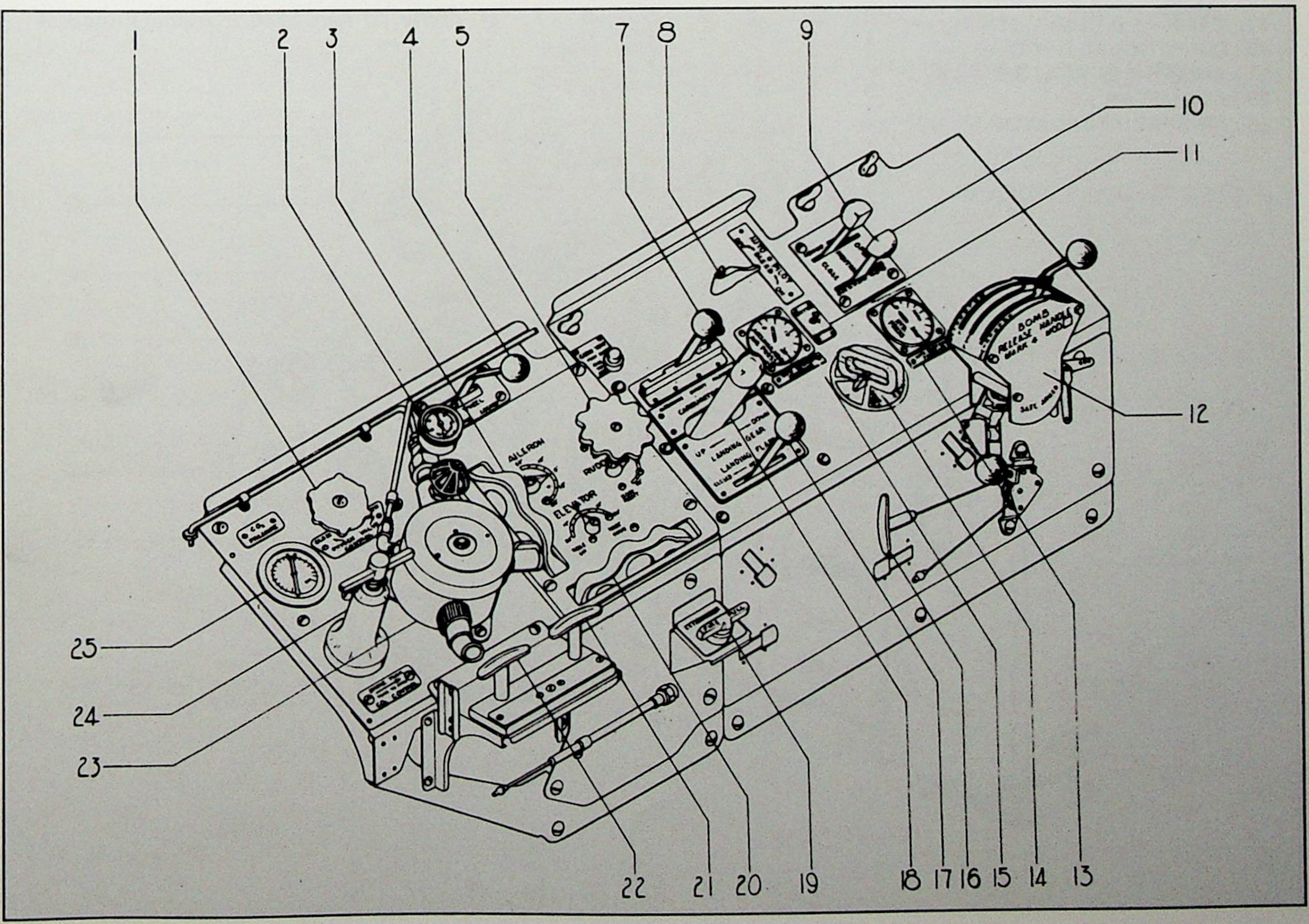


PILOT'S LEFT-HAND CONSOLE

1.) OXYGEN VALVE CONTROL
2.) OXYGEN GAGE
3.) AILERON TRIM TAB CONTROL
4.) TAIL WHEEL LOCK CONTROL
5.) RUDDER TRIM TAB CONTROL
7.) CARBURETOR AIR CONTRL
8.) AUTOPILOT VALVE
9.) BOMB DOOR CONTROL
10.) DIVE BRAKES CONTROL
11.) DUPLEX FLAP CONTROL SWITCH
12.) BOMB QUADRANT
13.) HYDRAULIC PRESSURE GAGE
14.) FUEL SELECTOR VALVE
15.) HYDRAULIC ACCUMULATOR AIR PRESSUE
17.) LANDING FLAPS CONTROL
18.) LANDING GEAR CONTROL
19.) EXTINGUISHER
20.) ELEVATOR TRIM TAB CONTROL
21.) TOW TARGET RELEASE CONTROL
22.) SMOKE TANK CONTROL
23.) DILUTER-DEMAND REGULATOR
24.) CARBON DIOXIDE CONTROL
25.) CARBON DIOXIDE PRESSURE GAGE

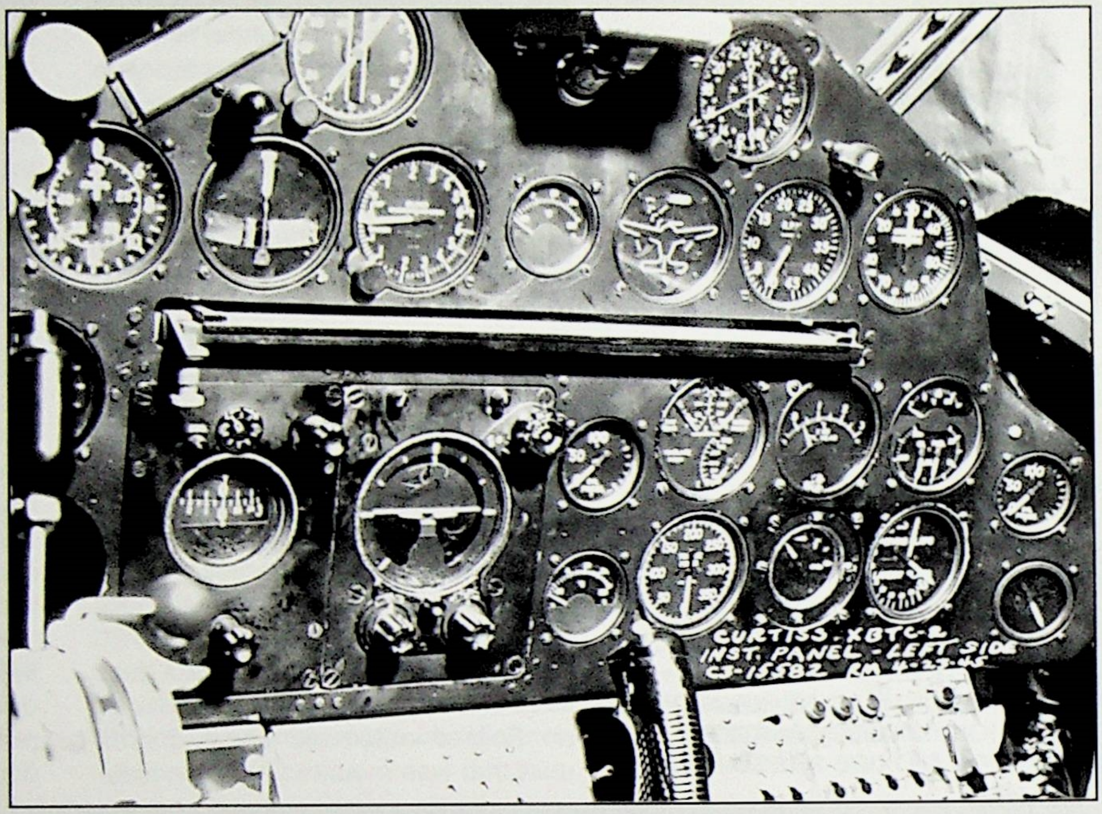
power quadrant, however, was any pilot-control for the single- stage, variable-speed supercharger installed on our models (-8a & -14) of the R-4360. Instead, the pilot was presented with the advanced (at least for United States-built airplanes) feature of an automatic boost control wherein his throttle lever was no longer connected to the carburetor but, to use Navy terminology, a manifold pressure regulator. The use of a manifold pressure regulator would prevent over-boosting of the engine, maintain constant MAP regardless of change in altitude (ie. within the limits of the supercharger and thereby eliminating the constant need to advance the throttle during the climb to altitude), and ensure that the supercharger impeller was driven at the lowest speed necessary to maintain the desired MAP. These automatic boost control features were made possible because of an Eclipse automatic boost control unit[6] that was mounted on the accessories case of the R-4360. Now the pilot's throttle lever and mixture control were linked to the manifold pressure regulator which, through a series of bellows, actually controlled the carburetor throttle. This allowed the manifold pressure regulator to control the engine's MAP without causing any movement of the pilot's throttle. Any of the various failures of the manifold pressure regulator would, within the limits allowed by the design of the regulator, require manual operation of the throttle.

The supercharger installed was a single-stage, variable speed type where the variable speed feature was created by a pair of hydraulic couplings, ie one offering a low ratio while the other the high ratio. The installation of this supercharger changed the flow-pattern of the air intended for combustion. On the majority of the previously used superchargers, the combustion air entered through its

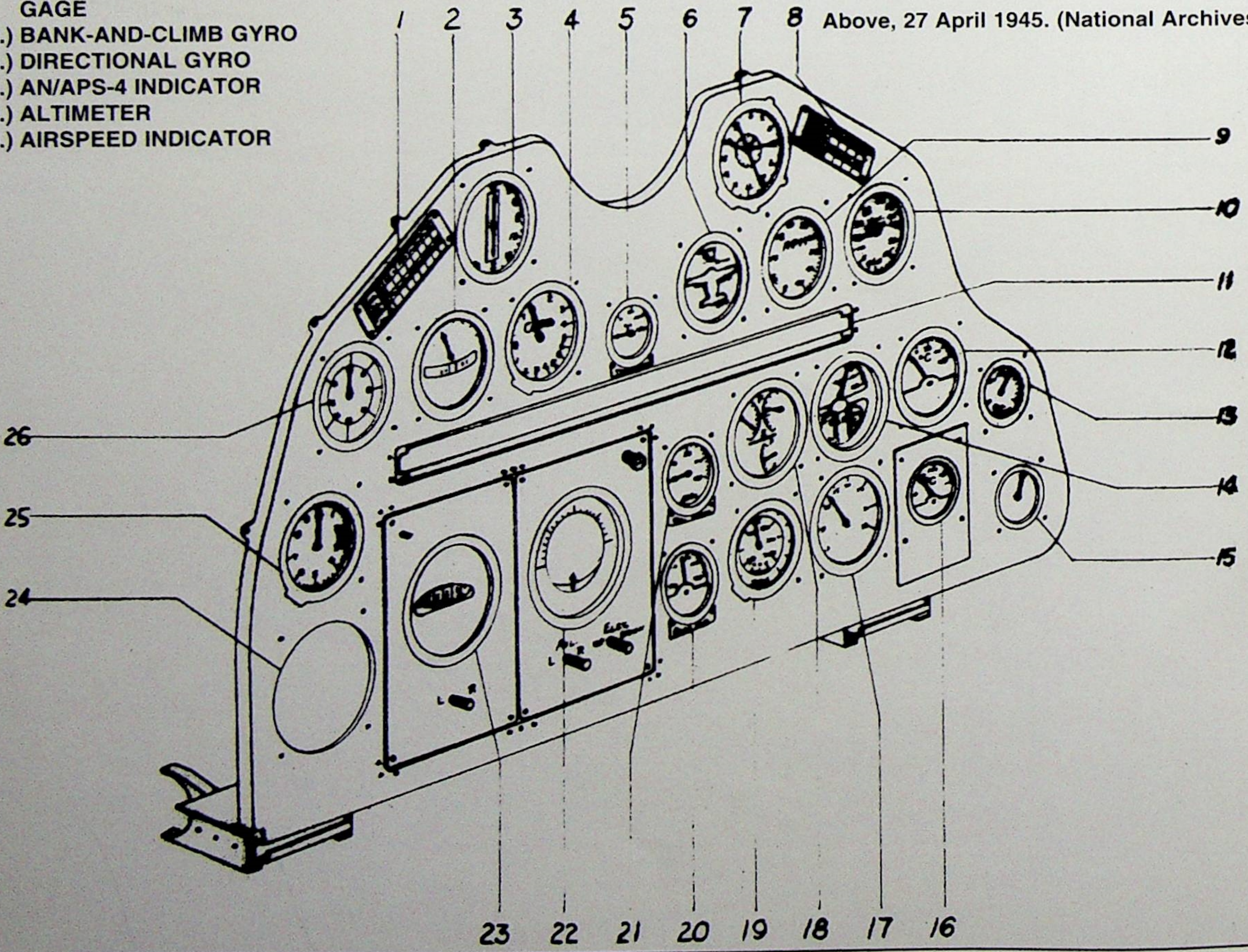


XBTC-2 INSTRUMENT PANEL

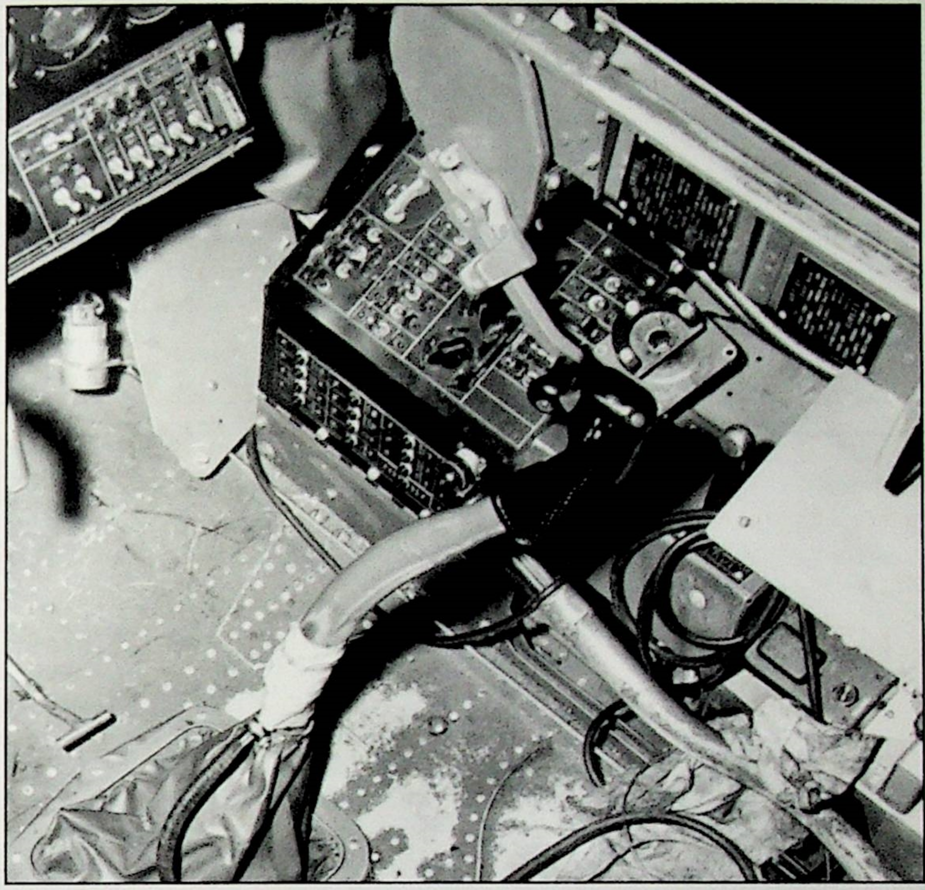
1.) REMOTE COMPASS CORRECTION CARD
2.) TURN-AND-BANK IND.
3.) REMOTE INDICATING COMPASS
4.) RATE-OF-CLIMB IND.
5.) CARB AIR TEMP. GAGE
6.) WHEEL AND FLAP POSITION INDICATOR
7.) CLOCK
8.) AIRSPEED CORRECTION CARD
9.) TACHOMETER
10.) MANIFOLD PRES. GAGE
11.) CHART BOARD
12.) CYL. HEAD TEMP. GAGE
13.) ENGINE REAR OIL PRES. GAGE
14.) ENGINE GAGE UNIT
15.) OIL COOLER FLAPS POSITION INDICATOR
16.) OIL OUTLET TEMP GAGE
17.) FLOWMETER
18.) FUEL QUANTITY GAGE
19.) HORSEPOWER INDICATOR
20.) FREE AIR TEMP. IND.
21.) AUTOPILOT OIL PRESSURE GAGE
22.) BANK-AND-CLIMB GYRO
23.) DIRECTIONAL GYRO
24.) AN/APS-4 INDICATOR
25.) ALTIMETER
26.) AIRSPEED INDICATOR

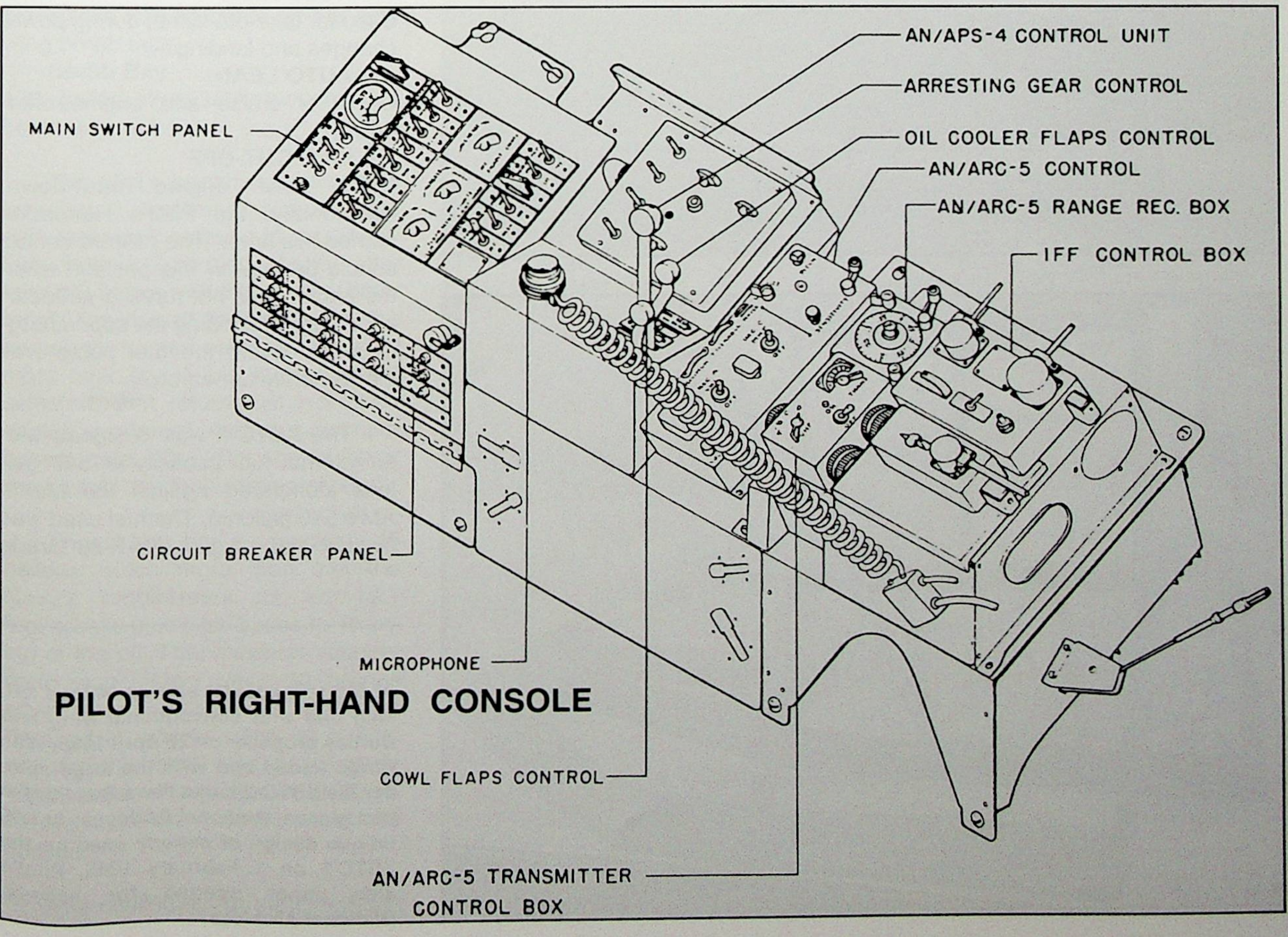


Above, 27 April 1945. (National Archives)

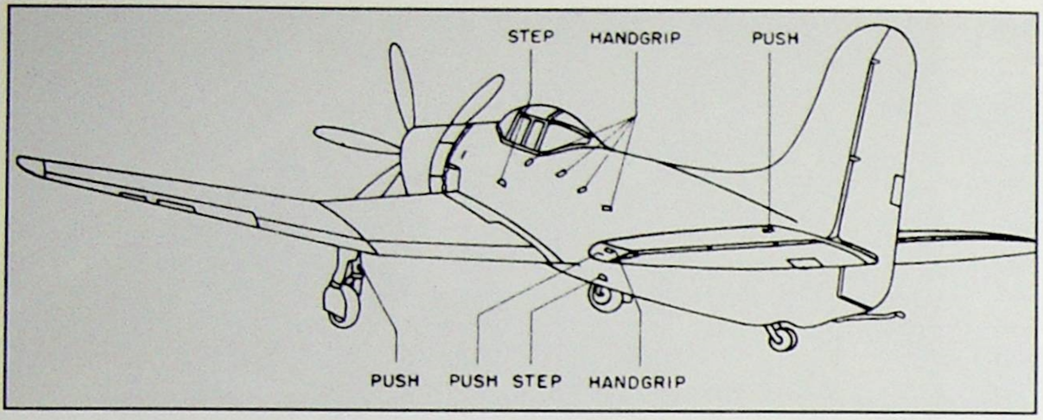


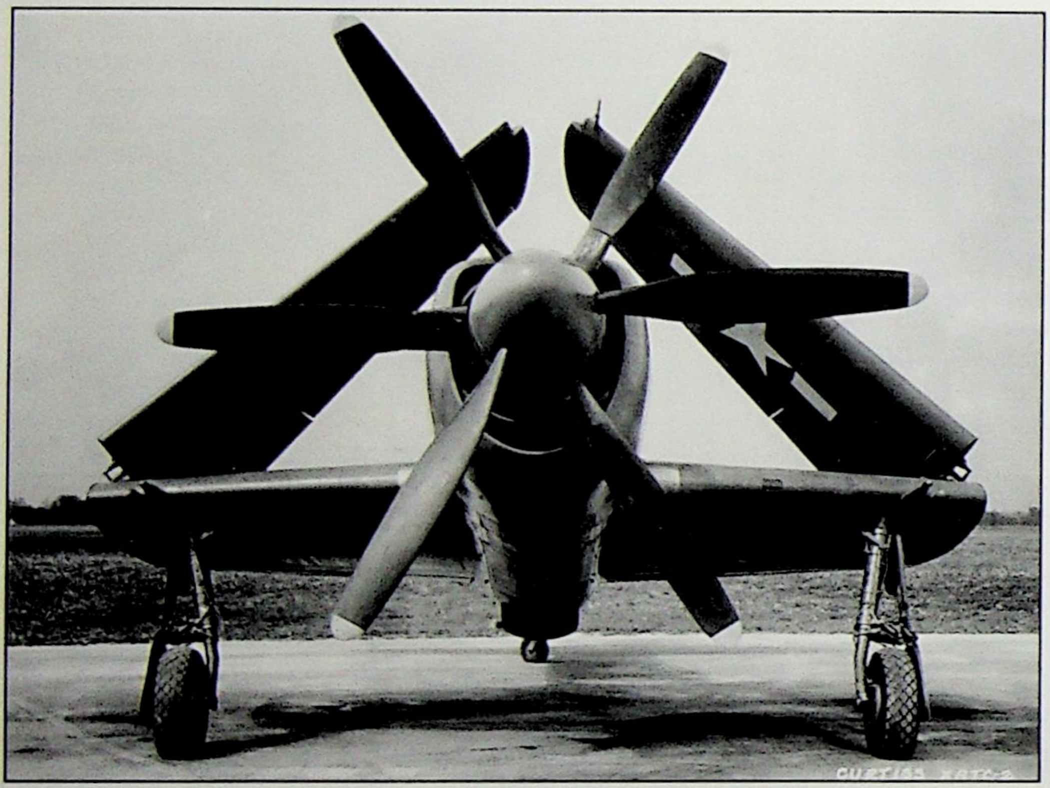
dedicated air scoop, passed along through a duct to the supercharger. After being compressed, the air would pass through an intercooler (where some of the heat caused by that act of compression was removed) before being made available to the carburetor. The carburetor would mix the fuel vapor and air into the desired ratio and distribute it through the intake manifold to each cylinder. On our R-4360s the combustion air would enter the cowling through one of its two top-mounted air scoops, proceed through the firewall to the carburetor, where in response to inputs from the manifold pressure regulator and the pilot's mixture control, combine the combustion air with the fuel vapor into the correct ratio before being routed to the supercharger. The supercharger would then vary its RPM (remember variable speed) so as to turn at the minimum RPM necessary to pressurize, or boost, the fuel/air mixture to match the pilot's throttle-selected MAP. From the supercharger, the fuel/air mixture would be distributed through one of the seven (one for each bank) intake manifolds arranged in a centrifugal pattern. Each intake manifold would then

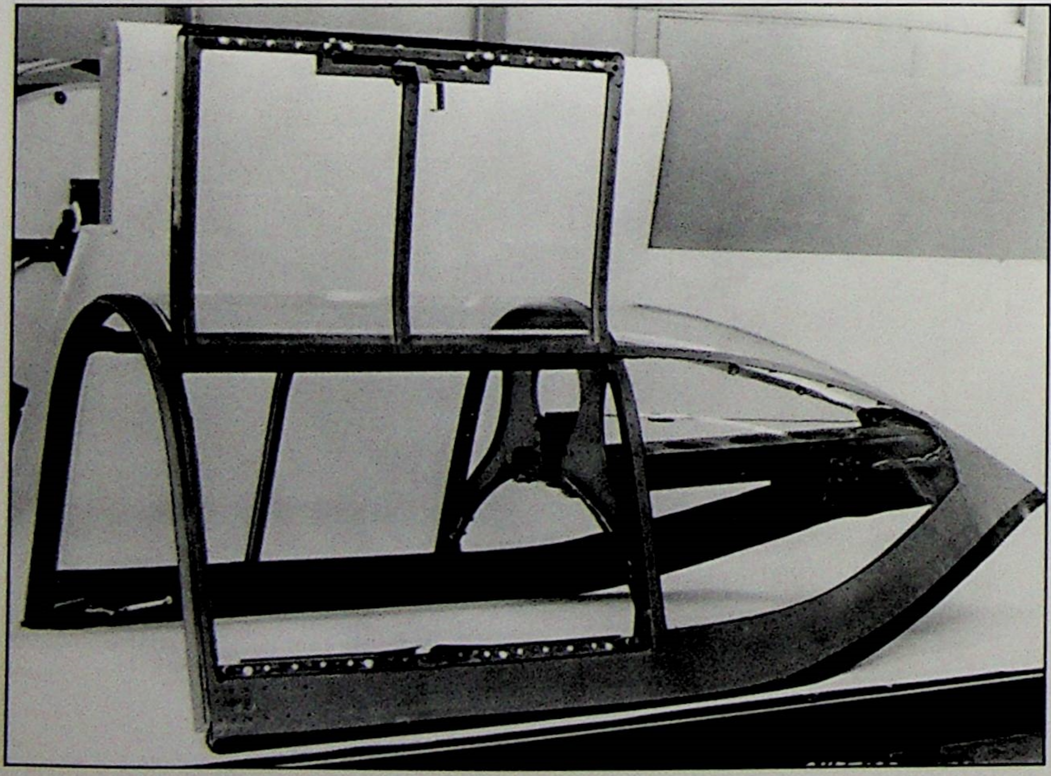




PILOT'S RIGHT-HAND CONSOLE







provide the fuel/air mixture to each of that bank's four cylinders. This system eliminated the use of an intercooler and the attendant drag of its air scoop. Although this type of supercharging offered tremendous flexibility, its inefficiencies, mostly caused by slippage, were transferred into heat.

Bendix PR-100-A3-1/B2-3 carburetors were installed on the XBTC-2 but the Navy also showed interest in the CECO 100-CPB7-1 carburetor which was the carburetor installed on the Martin AM-1's R-4360-4W.

The mixture control had four positions, reading from the front of the power quadrant aft they were:

FULL RICH
Needed to be selected before water injection could be used. This was a way to increase power by using fuel that was excess to the combustion process to help cool the engine (lower cylinder head temperature).

AUTO RICH
Used for take-off, climb, during power changes and landing.

AUTO LEAN
Used for cruise and engine shut-down.

IDLE CUT-OFF
Used after engine shut-down. Additionally, the Pilot's Handbook carried this note, "The mixture control should be kept in this position when the engine was not running as insurance against flooding the supercharger in the event the fuel pump was inadvertently turned on."

The XBTC-2 was designed with an internal fuel capacity of 540 gallons (compared against the Martin AM's 510 gallons). The fuel used was aviation gas (avgas) AN-F-28 Grade

At top left, cockpit access. Above left, ship one with conventional wing and Curtiss propeller on 28 April 1945. With wings folded and with the large spinner the XBTC-2 looks like a Sea Fury at first glance. (National Archives) At left, unique design of canopy used on the XBTC-2 on 1 February 1945. Pilot's side panel opened for access. (National Archives)

100/130 that was carried in two 90 gallon interconnected fuselage tanks and two 180 gallon wing and fuselage combination tanks. During the XBTC-2's development, the use of external, droppable fuel tanks was incorporated. This arrangement of tanks resulted in a fuel tank selector valve that had the following seven positions:

Fuselage Main
Two interconnected fuselage tanks.

Left Main
Left wing and fuselage combination tanks.

Right Main
Right wing and fuselage combination tanks.

Off
Turned the fuel supply off, probably at the point where fuel tank lines joined in a common manifold.

Left Drop
Drop tank, either the 100 gallon or 150 gallon size mounted on the left wing bomb rack.

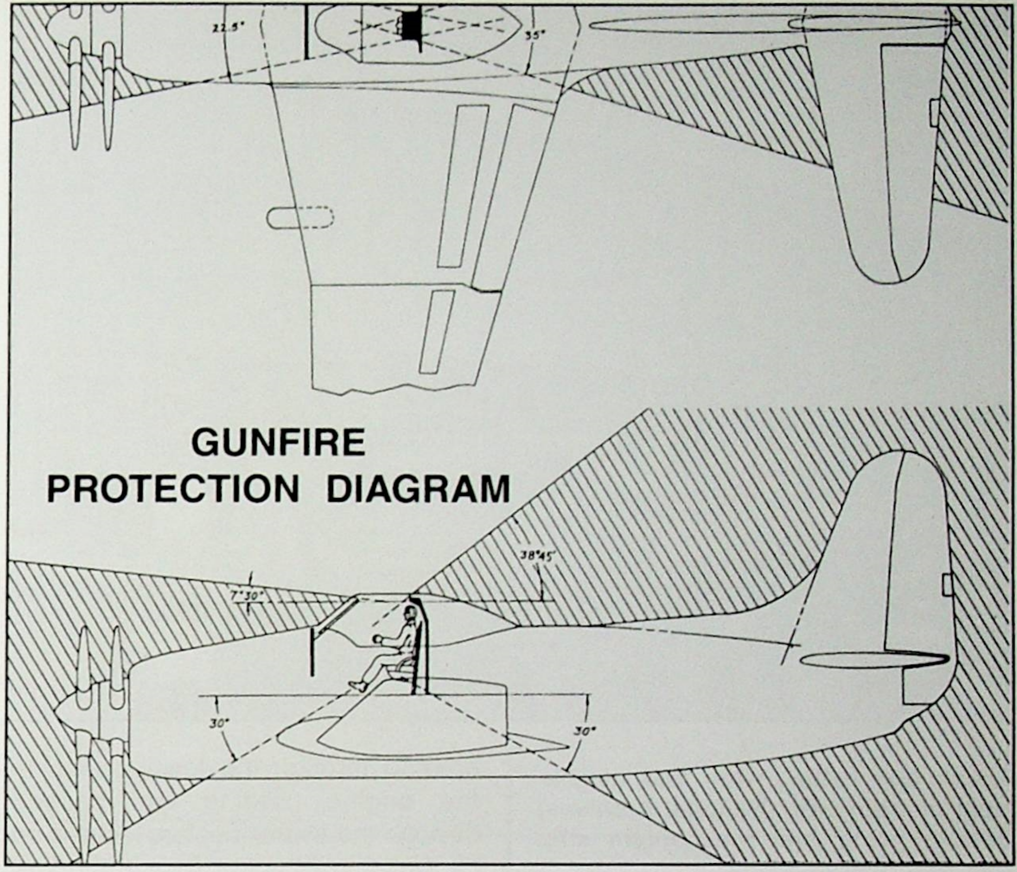
Right Drop
Drop tank, either the 100 gallon or 150 gallon size mounted on the right wing bomb rack.

Bomb Bay
130 gallon drop tank mounted on bomb bay rack.

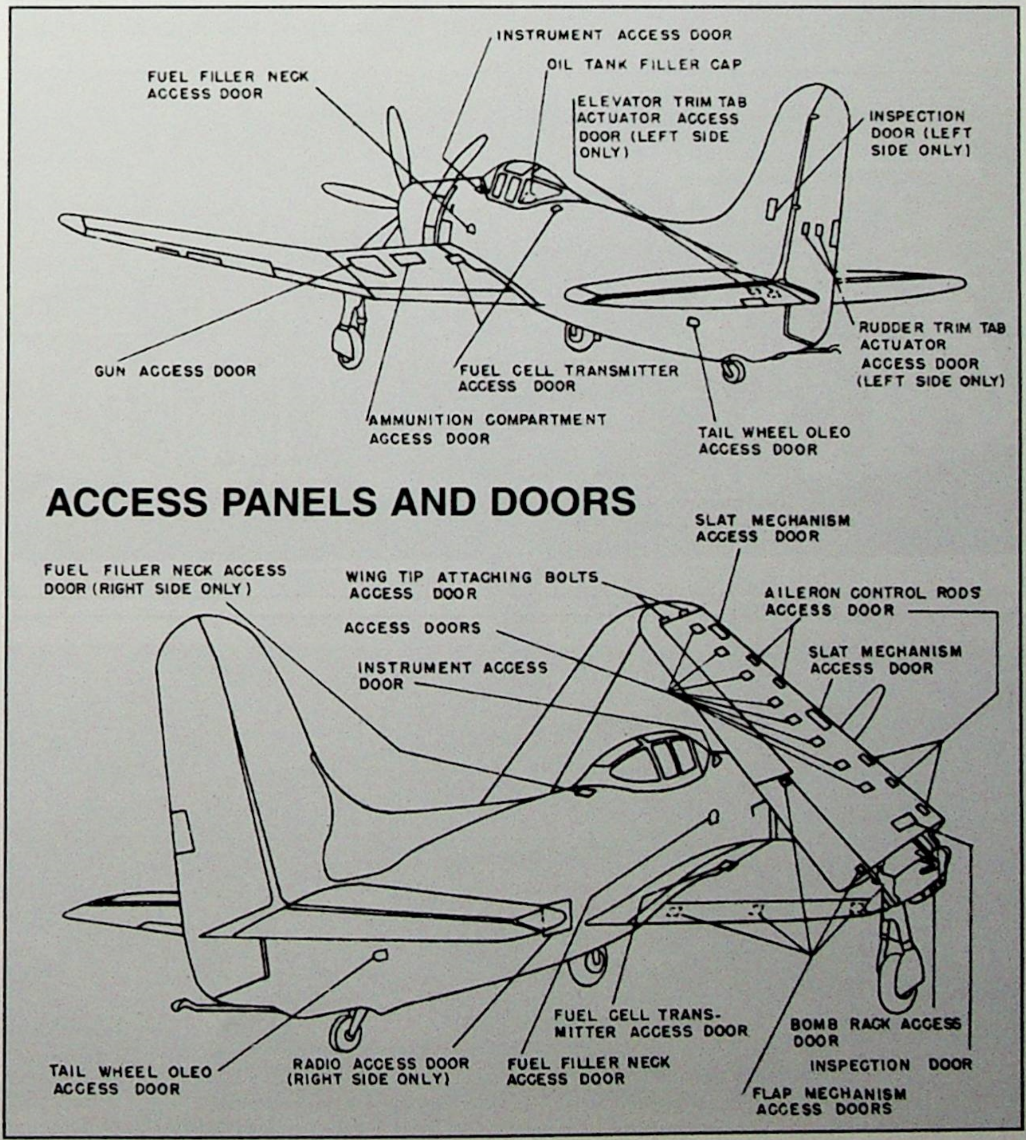
The pilot's operating procedures included: "...start the engine using the right main tank and use about 20 gallons from it (reached shortly after take-off) before switching to any other tank". The reason for that being, the carburetor vented back into the right main tank so, if this tank was not selected, that return fuel would be vented overboard. And as a last cautionary note, "The pilot should never drain (run) any tank completely dry".

The oil tank had a capacity of 45 gallons which more than met the Navy's requirement for an 18:1 fuel/oil ratio plus 5 gal space for foaming of the oil. That minimum requirement would have been 30 gallons which could include oil that was "trapped in system". The oil in fleet use for this time was 1120 grade which required a minimum of 30° C before take-off power could be applied.

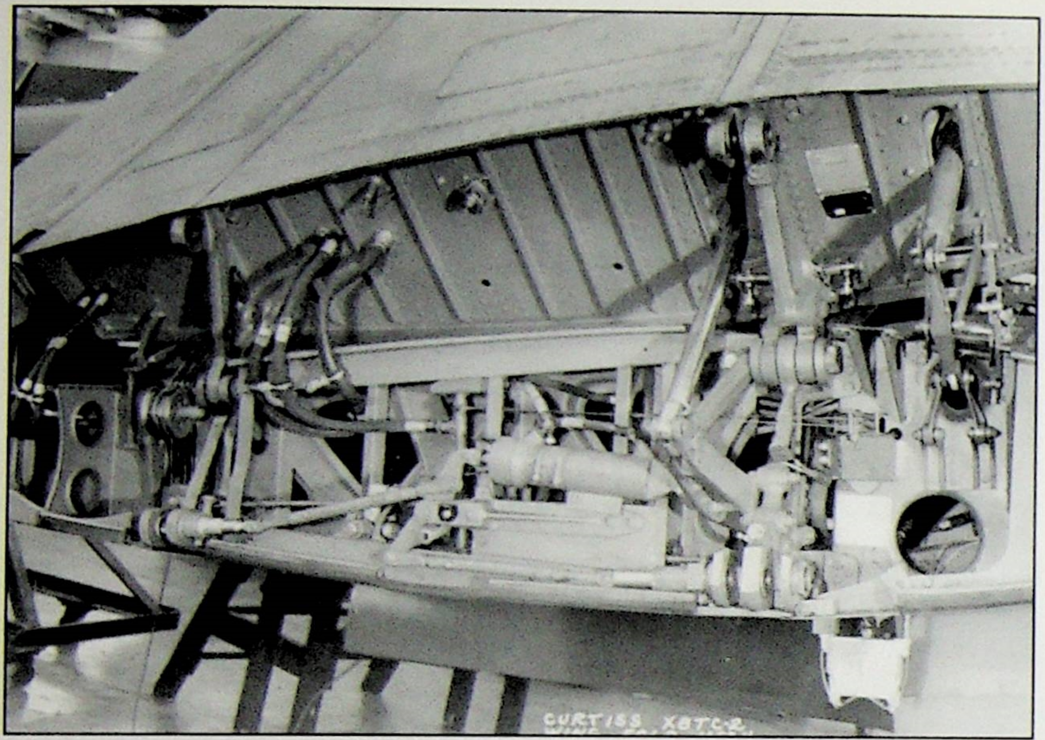
The cooling air for the oil system

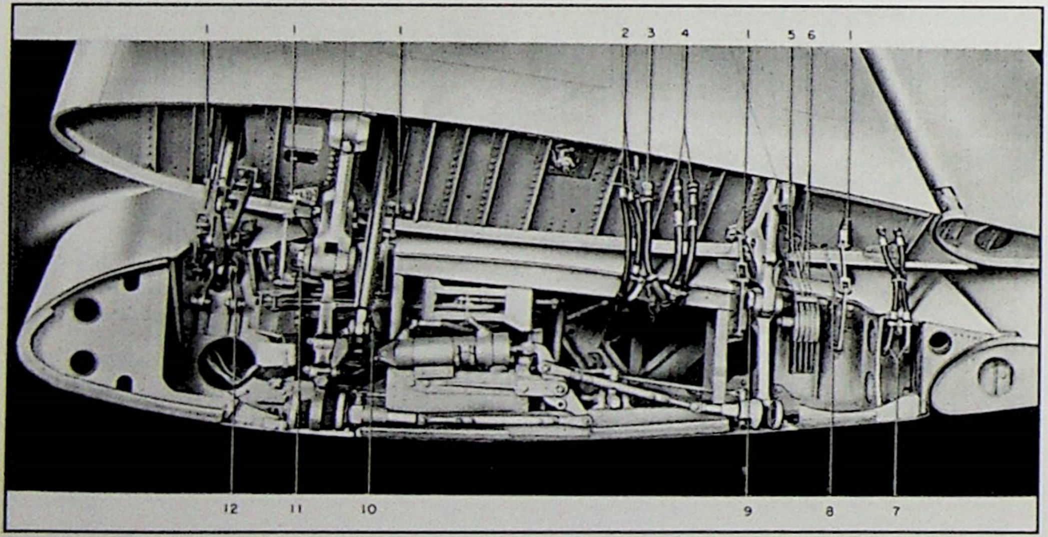


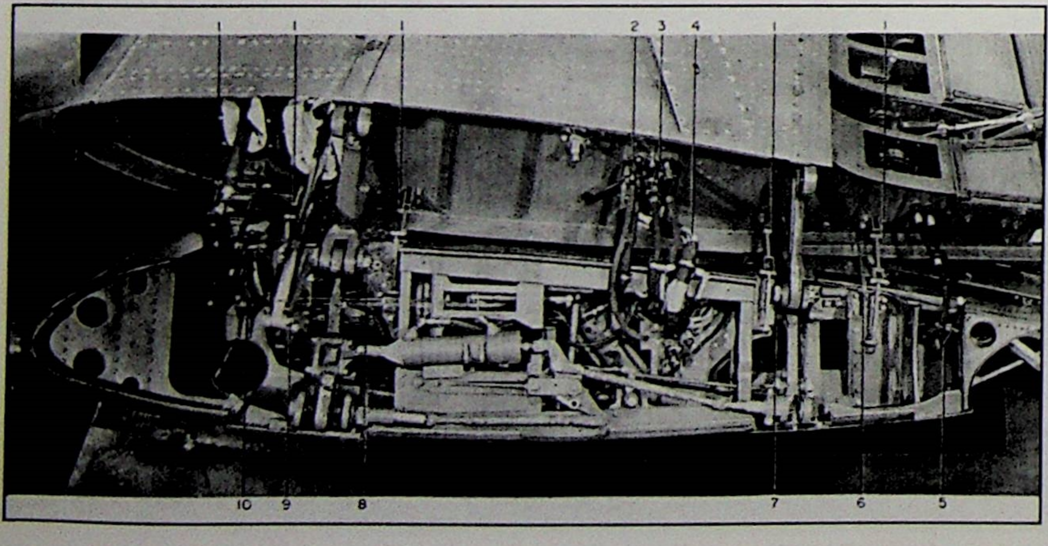
GUNFIRE PROTECTION DIAGRAM



ACCESS PANELS AND DOORS







Above and below, wing fold mechanism on ship one. (National Archives) Bottom, wing fold mechanism ship two. (National Archives.

entered through the lower scoop in the engine cowling and passed through the two oil coolers located on the bottom of the fuselage in the firewall. From there the now-heated air passed through the bomb bay before exiting through the oil cooler flap located aft of the bomb bay. The oil cooler flap control was located alongside the cowl flap control on the lower right main instrument panel next to the oil cooler flap's position indicator. The Pilot's Handbook noted, "After engine start, the oil cooler control should be in the "CLOSED" position as an aid in warming-up the engine". This warm-up was necessary because the oil pressure relief valve was fitted with a temperature control that caused the oil, when cooler than 40 C (104 F), to be forced through the engine under high pressure. To which the Pilot's Handbook adds this scary thought, "The pressure may reach 400 psi or more when very cold".[7] For some perspective on this matter of oil pressure, at 2000 RPM and 30" Hg of manifold pressure, the settings for the power plant check, the oil pressure should be 85 to 90 psi. Once the oil temperature reached 40C, the oil cooler flap would be opened and take-off power could be used.

The last engine feature that we'll mention is the exhaust system. The exhaust cooling was accomplished by manifolding the four exhaust valves of each cylinder in a bank into one exhaust pipe. That exhaust pipe then extended aft so as to discharge into the atmosphere under a cowl flap. By placing this exhaust pipe in the optimum position relative to its cowl flap, additional cooling air was forced through that cowl flap, adding its thrust to that of the propeller. This system was known as an "open stack" exhaust system and generally used by aircraft whose mission profile did not exceed 15,000 ft.

For "Extreme Weather Operations" (Pilot's Handbook terminology) a carburetor heat control was located on the left-hand console. This lever had three positions which, starting with the rearmost and reading forward, were:

ALTERNATE
Used when "icing conditions exist". When selected, warm air from around the cylinders was routed into the air scoop duct. Although this heated air

prevented the formation of carburetor ice, the pilot was without any capability to modulate the amount of warm air selected. If icing conditions existed before take-off, the pilot could select the Alternate position to clear the induction system but then he needed to switch to "Direct" for take-off.

DIRECT
Used for engine starts and normal operations. Here the air that entered through the air scoop flowed directly to the manifold pressure regulator.

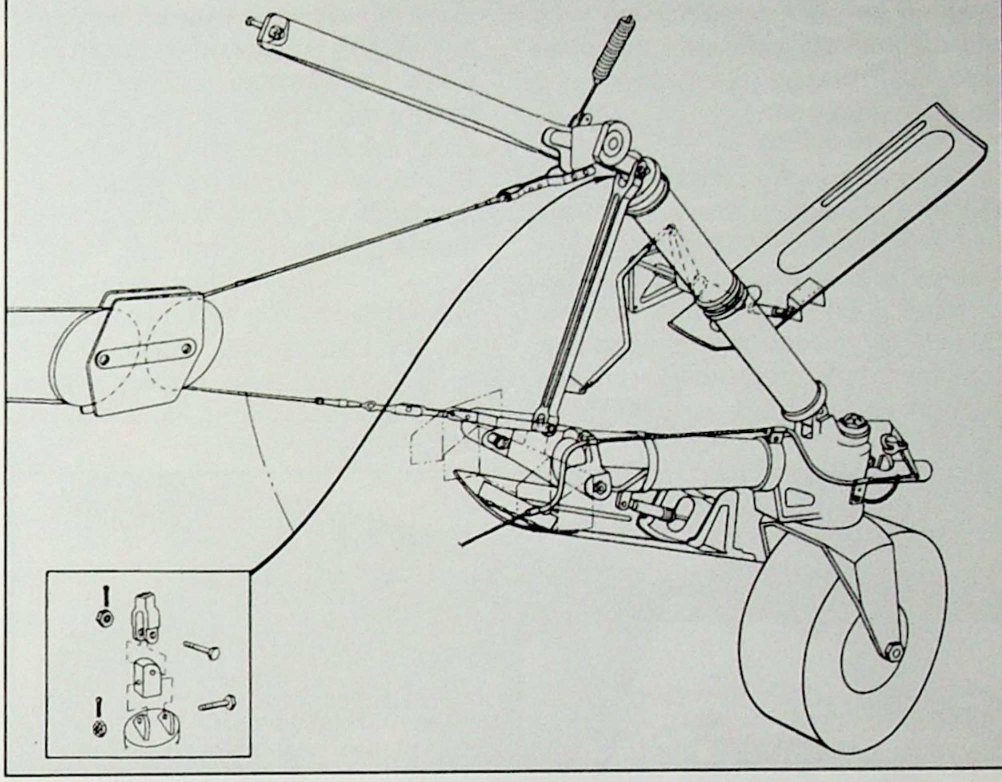
FILTER
Used for ground operations in a dusty environment like winter-time in Texas. This system was subsequently dropped from use and, in fact, didn't appear on the Martin AM-1's carburetor heat control.

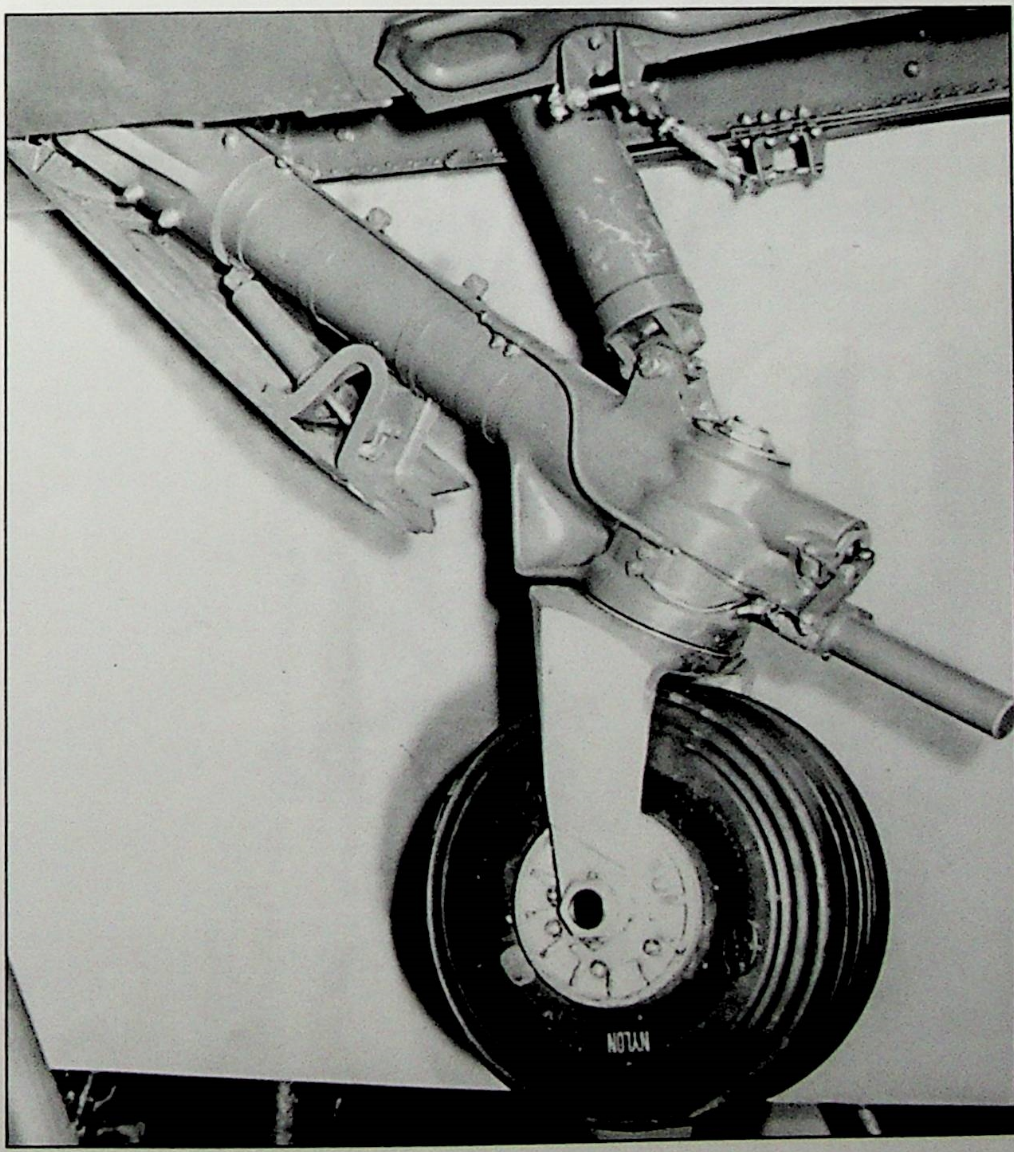
The XBTC-2 was equipped with an oil dilution switch and valve that were to be used prior to shutting down the engine when the temperature was forecast to be below 23F. This "Oil Dilution Procedures" check list was a lengthy procedure that involved the pilot holding the oil dilution switch "ON", starting with 4 minutes prior to shutting the engine down and continuing until after the engine shut down. For the next engine start the pilot needed to be alert for either fluctuating or dropping oil pressure, in which case he was to shut down the engine.

In keeping with prevailing practice, the airplane was equipped with a carbon dioxide fire extinguishing system that consisted of controls for the pilot located aft on the left-hand console, a CO2 tank and warning light.

The hydraulic system consisted of three separate sub-systems: the power system, the primary system and the secondary system. Taking the systems separately, the power system consisted of all the equipment and lines necessary to provide hydraulic pressure, which included the engine driven hydraulic pump, the hydraulic tank, an accumulator and an unloading valve. The primary system consisted of all the lines and equipment necessary for the opera-

XBTC-2 TAIL WHEEL



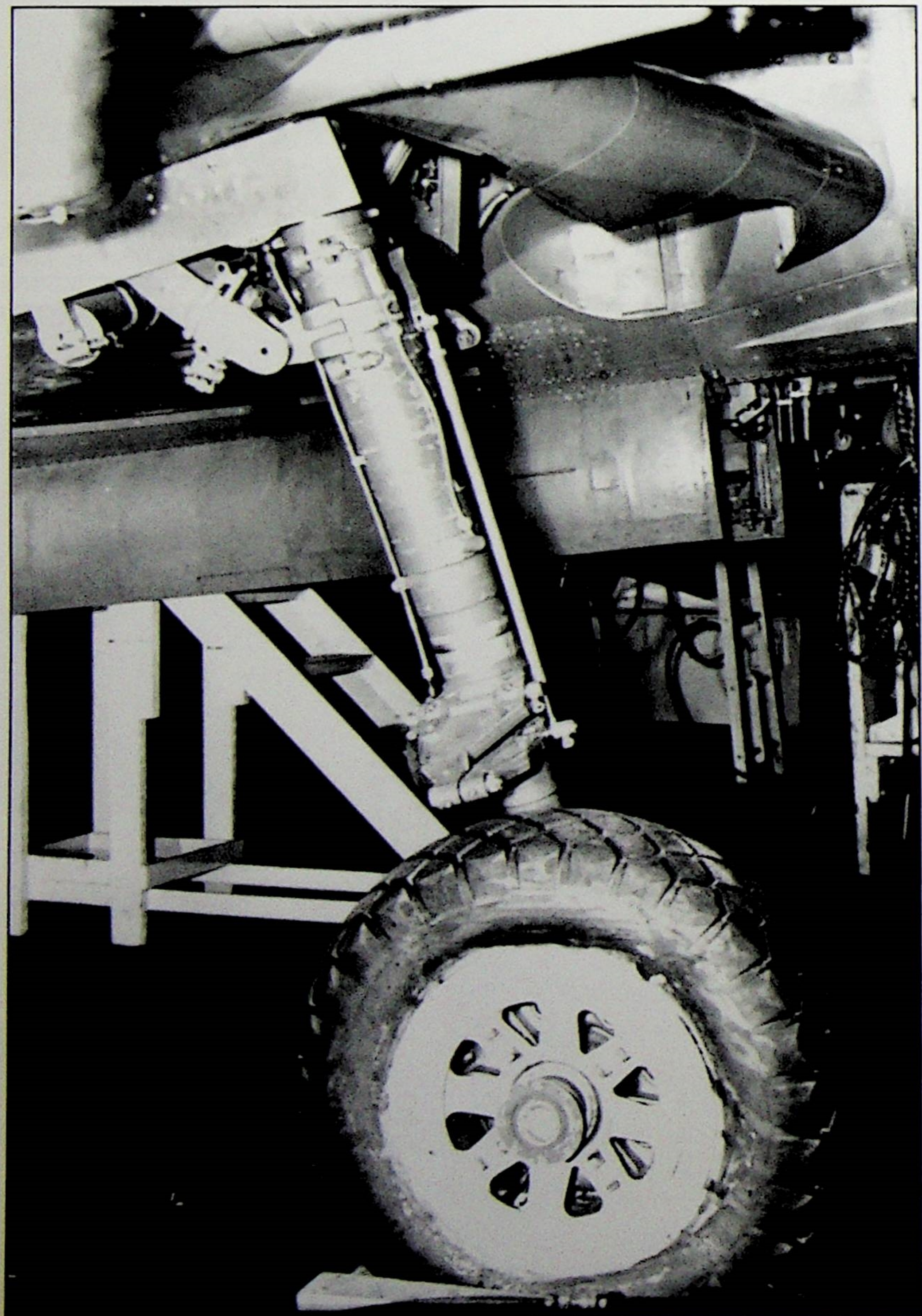


tion of the landing gear, flaps, slats and brakes. The secondary system included the gun chargers, the wing fold mechanism, cowl and oil cooler flaps, dive brakes, bomb doors and the displacing gear.

To maintain the primary system's ability to function in the event of the loss of hydraulic fluid in the power system, a check valve was installed between it and the primary system. This check valve allowed fluid to flow from the accumulator to the primary system but not in the reverse direction. In the event of a complete loss of hydraulic fluid in the power system, the hydraulic tank was so arranged that roughly 6 quarts of hydraulic fluid would be available for use by the hand pump located to the left of the pilot's seat. This amount of hydraulic fluid quantity was in the words of the handbook, "...ample fluid to operate the system in an emergency."

Similarly, if the hydraulic leak was in the secondary system, the hydraulic fluid in the primary system could be isolated from the secondary system by the pilot's use of his "Secondary" valve. The pilot's control for the Secondary valve was located on the upper left-hand side of the cockpit sill and normally kept in the "OPEN" position. This "OPEN" position allowed hydraulic fluid to flow from the primary system to the secondary system, allowing those units to be hydraulically operated. But when the Secondary valve was placed in the "CLOSED" position, the primary system's hydraulic fluid was blocked from flowing into the secondary system, thereby rendering its components inoperative. In addition, a by-pass valve was located of the left side of the cockpit for use during emergency operations to dump all pressure in the entire hydraulic system. For normal operations the Secondary valve should be "OPEN" and the by-pass valve "CLOSED".

This hydraulic system was a closed center type of hydraulic system. In this type of system, the hydraulic fluid was pressurized by the engine driven hydraulic pump from where it flowed to the accumulator (known as charging the accumulator). Once the accumulator reached full charge, the unloading valve then diverted the pump flow to the reservoir while a check valve trapped the pressurized hydraulic fluid in the circuit. When the pilot operated a hydraulically-operated control, pressurized hydraulic fluid flowed from the accumulator through the check valve to the control cylinder of the unit the pilot had selected. As hydraulic pressure began to drop, the unloading valve directed the hydraulic pump flow to the accumulator, recharging the accumulator. This type of hydraulic system allowed the use of a small capacity pump (good because it took less horsepower from the engine) and was effective when the operating hydraulic fluid was needed for a short time, like the movement of any hydraulically operated control.



At left, XBTC-2 right main gear minus gear doors looking inboard with bomb bay doors open. (National Archives)

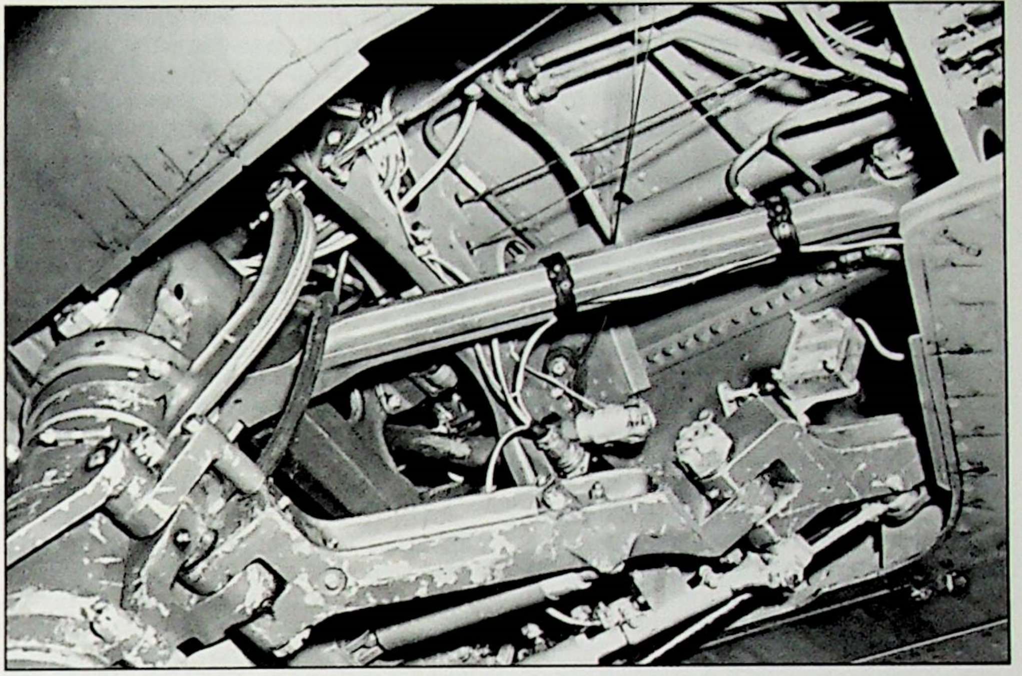
The pilot could monitor the operation of the hydraulic system through two gauges: the hydraulic system pressure gauge and the hydraulic accumulator air pressure gauge. Both gauges were located on the left-hand console and with the engine running in normal operations indicated 850 to 1050 psi. Being a closed-center hydraulic system, all hydraulic control valves except the landing gear and wing fold control had a neutral, position which the pilot needed to select once that unit was properly positioned. The landing gear control was located in the center section of the left console and moved forward to extend the gear and aft to retract it. Then, to point out a major difference in the pilot's operation of the hydraulic control, the pilot's Handbook adds:

"DO NOT MOVE THE CONTROL OUT OF THE "DOWN" POSITION UNTIL IT IS DESIRED TO RETRACT THE GEAR. DO NOT MOVE IT OUT OF THE "UP" POSITION UNTIL IT IS DESIRED TO EXTEND THE GEAR".

The wing fold controls were located under the center of the main instrument panel. They consisted of a red hinge pin locking handle and a white control valve handle. Red warning pop-up flags were located on the upper and lower surfaces of both wings, becoming visible when the hinge pins were not locked in place. To spread the wings, the pilot lifted the white control knob "UP" before releasing it. Then he would push the red pin locking handle full forward and check with the help of a ground crewman that the red warning flags "had disappeared from the surface of the wing".

Now the hydraulic system begins to show its early WW II heritage, The tail wheel, although a retractable type, was operated by a cable connected to one of the main landing gear struts. As the main landing gear was retracting, that cable's movement pulled the tail wheel up. Since there is no mention of the tail hook in the hydraulic system (it's listed as an auxiliary control), one could suspect that it also was cable-operated. To drop the hook, the Pilot's Handbook states that the "Arresting Gear Control", which was a long lever located on the right console, should be pull aft. Retraction then could have been accomplished by the arresting gear crewman who, after clearing the tail hook from the arresting cable, would shove the tail hook back into its retracted position.

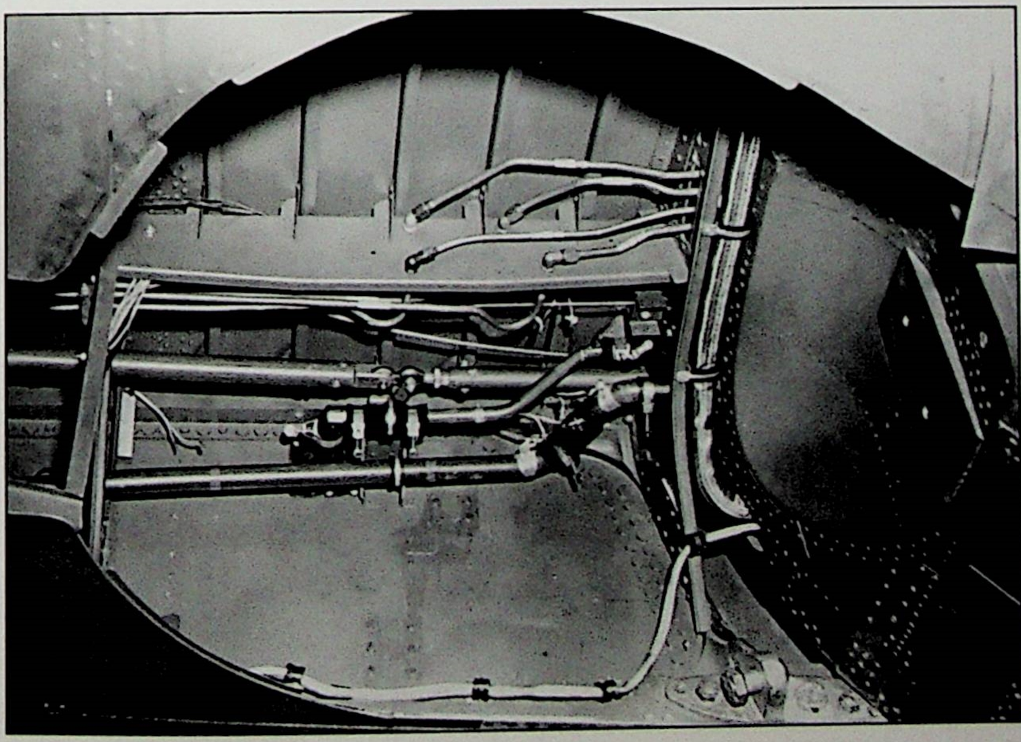
Although the autopilot[8] is not listed as a component of either the hydraulic system or electrical system,



Above, outboard right main landing gear well. (National Archives) Bottom, inboard right main landing gear well looking aft. (National Archives)

it can be described as electrically-controlled and hydraulically-operated. The hydraulic control was through the Auto Pilot Valve located on the left-hand console, with "OFF", "BLEED" and "ON" positions. In the "OFF" position, the pressurized hydraulic fluid from the power system was routed through the Auto Pilot Valve and back to the reservoir through a return line. In the "BLEED" position, the hydraulic fluid would have been routed to a pressure regulator where its pressure was reduced to a maximum of 120 ±10 psi and the excess fluid was returned to the reservoir. This was monitored by an "oil pressure" gauge that was mounted on the main instrument panel. In the "ON" position this reduced-pressure hydraulic fluid was routed to three flight servo cylinders, one for each flight control located either inside or nearby the cockpit controls.

In automatic flight, the airplane



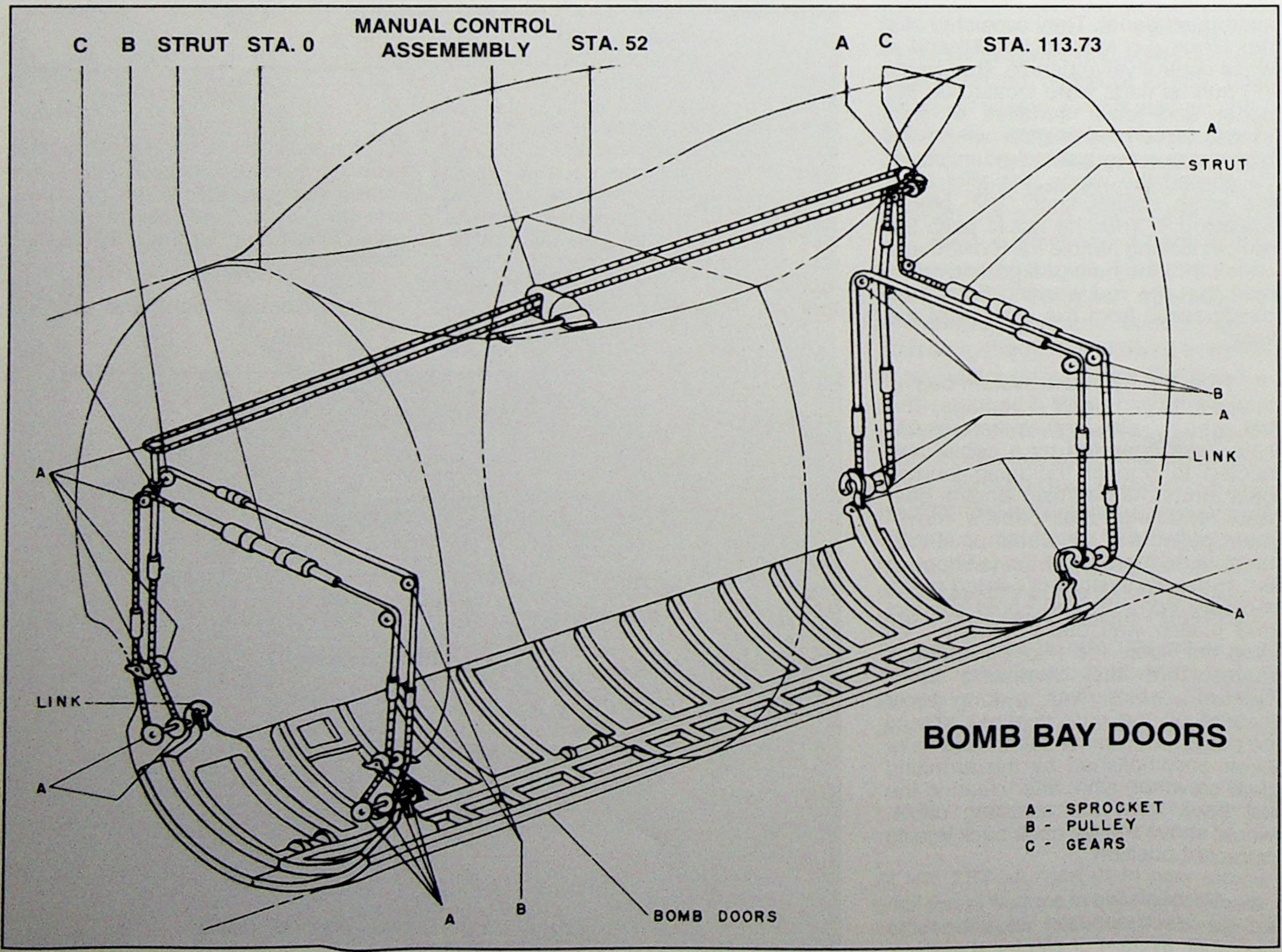
was controlled directionally by the directional gyro and both longitudinally and laterally by the bank-and-turn gyro.. Both gyros were vacuum- powered[9].and along with their adjustment control knobs, located on the main instrument panel just beneath the slot used to stow the pilot's plotting board. The rudder adjustment control knob was located beneath the directional gyro while the elevator and aileron trim adjustment control knobs were located beneath the bank-and-climb gyro. These adjustment control knobs would respond to the pilot's turning by sending an electric signal to its respective servo control, ultimately causing hydraulic pressure to displace that flight control. In normal operations, both gyros would have been caged periodically to avoid "precession", and before acrobatic maneuvers to preclude "tumbling-the-gyros".

The electrical system was powered by two 12-volt batteries connected in series and by an AC-DC generator with a DC rating of 28 volts, 200 amperes, and an AC rating of 115 volts. In addition to the engine starter, primer and auxiliary fuel pump, the electrical system as usual powered most of the instruments, radio equipment, pitot heater, windshield defroster, lights and fired the guns and released the armament. Additionally, the landing and take-off flaps of the duplex outer wing panels were powered electrically. All electrical controls, with exception of armament and the duplex flap controls, were located on the forward portion of the right console, with the circuit breakers mounted on the console side.

For use in "Extreme Weather Operations", an electrical defroster and pitot heater were installed. The electrical defroster was controlled by two switches, the left-hand one labeled "HIGH-LOW-OFF" and the right-hand one, "START-OFF". As another example of the early-1940's technology the following Handbook instruction's for operation of the defroster might prove interesting: "To operate the defroster, flip the left switch to "HIGH" or "LOW" depending on the severity of the weather, and hold the right switch on "START" until the windshield is defrosted. If there is no heat after this switch has been on "START" for three minutes, flip the switch to "OFF" to avoid burning out the glow plug in the heater." A pitot heat control switch was located on the electric panel and would be used in conjunction with the free air temperature gauge located on the bottom row of the main instrument panel.

The normal pre-flight check of the generator would start with the engine turning 1200 rpm or more and the pilot would turn the battery switch "OFF", then turn "ON" some interior light. At that point the voltmeter should read about 27 volts and if the lights were working, the pilot would know that the generator was functioning properly.

The XBTC-2 was equipped with a AN/ARC-5 VHF communication radio, the AN/ARR-2 Homing Re-



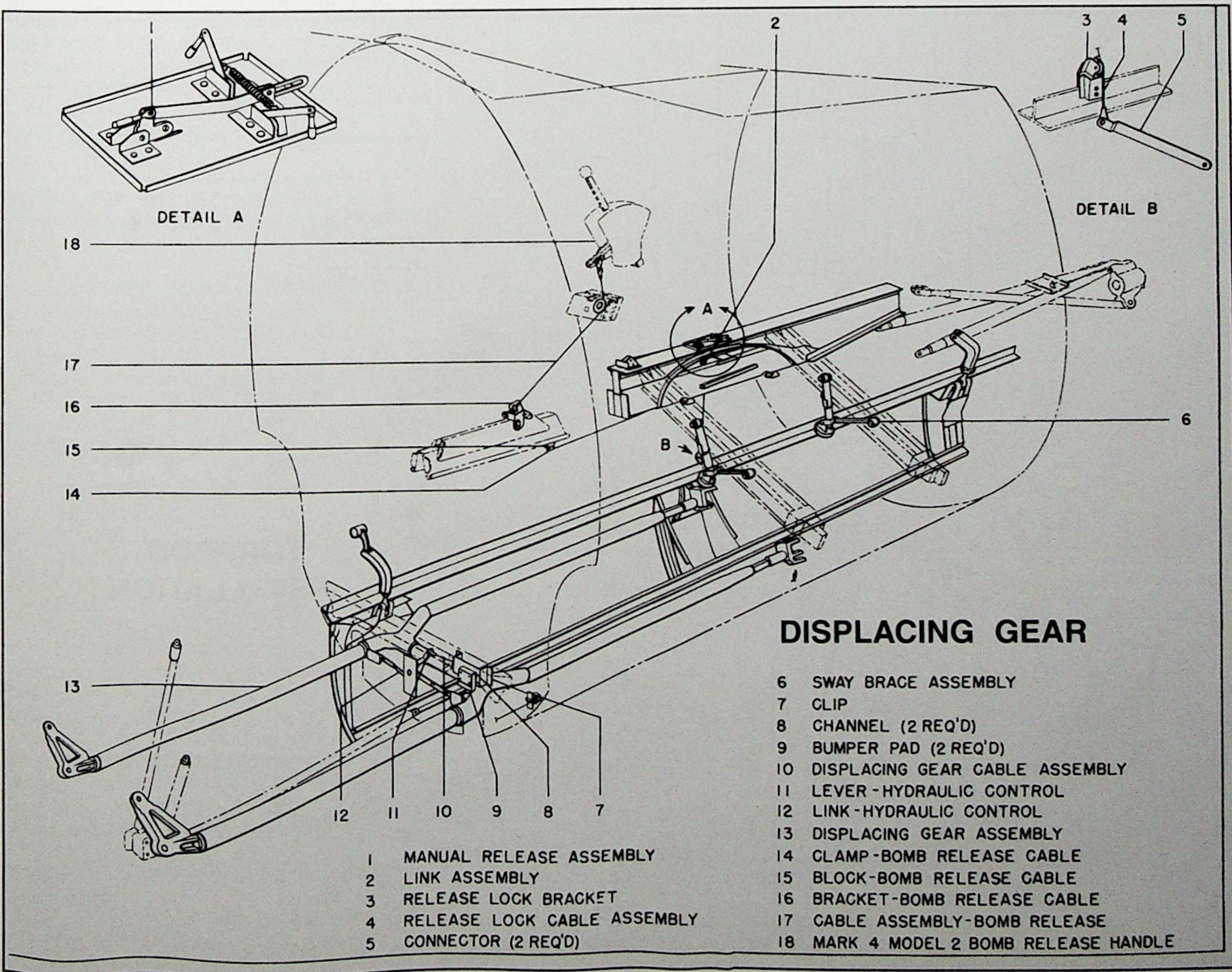
BOMB BAY DOORS

ceiver, an ARC-5 LF Receiver (coffee grinder for LF Range use, no ADF) and the model ABK (IFF) recognition equipment. The Pilot's Handbook states that the APS-4 radar pod would have been suspended from the starboard wing's bomb rack. And from that location, one can only wonder how much interference the contra-rotating propeller would have created thereby reducing, the effectiveness of the APS-4.

The oxygen system consisted of a 205 cu. in. oxygen cylinder located on the left side of the fuselage opposite the radio access door. Controls were located on the aft end of the left-hand console and consisted of an Oxygen Valve Control, Oxygen Pressure Gauge and a Diluter-Demand Regulator. The Oxygen Flow Indicator (blinking eye) was located forward on the left-hand console. The pilot's checks included turning the supply pressure regulator ON at which time he should see approximately 1800 psi. Then open the emergency valve and observe an oxygen flow through the regulator and mask. With the air valve in 100% Oxygen, inhale to determine if demand valve is operative. Turn "OFF" the oxygen supply pressure and after 5 minutes turn the oxygen supply pressure back "ON". If the pressure gauge needle deflected to the right, there was a leak.

Like its predecessor the SB2C, the XBTC-2 carried its main bomb inside a fuselage bomb bay and used wing bomb racks to carry its secondary ordnance. And, like most things in life, the dive bomber's use of a bomb bay had its pros and cons. The main advantage being that when the bomb bay doors were closed, the bomb bay offered less drag than an external bomb rack installation did. However, its disadvantages included the higher weight and complexity of its hydraulically-operated control system plus the fact that the XBTC-2 could carry just one bomb in the bomb bay.

The fuselage bomb installation consisted of a single Mk 51 bomb rack with adjustable sway braces, hydraulically operated displacing gear with an "H" type cradle and bomb bay doors. This installation had the capacity to carry a 1600 lb bomb but it could also accommodate any <u>one</u> of the following; 500 lb or 1000 lb bomb, 650 lb depth charge or a 1000 lb aircraft mine. The wing bomb installations also used a Mk51 bomb rack and sway braces contained within a fairing on each wing inner panel. For ordnance, each wing station could carry one 325 lb depth charge, 500 lb or 1,000 lb bomb. All three bomb racks were electrically controlled through switches on the armament switch panel and the release button on the pilot's control stick and cable operated. The armament switch panel was located just below the main instrument panel and included two



switches for arming either the nose or tail fuse of all bombs and five for selecting the stations from which the bombs would released either singularly or in train. The pilot would select the armament switch to "ON", and in the case of the bomb bay, "OPEN" the bomb doors. He knew when the bomb bay doors were open by a light on the armament switch panel before "pickling" the "BOMB" button on the top of his control stick to release the bombs.

BOMB LOADS FUSELAGE

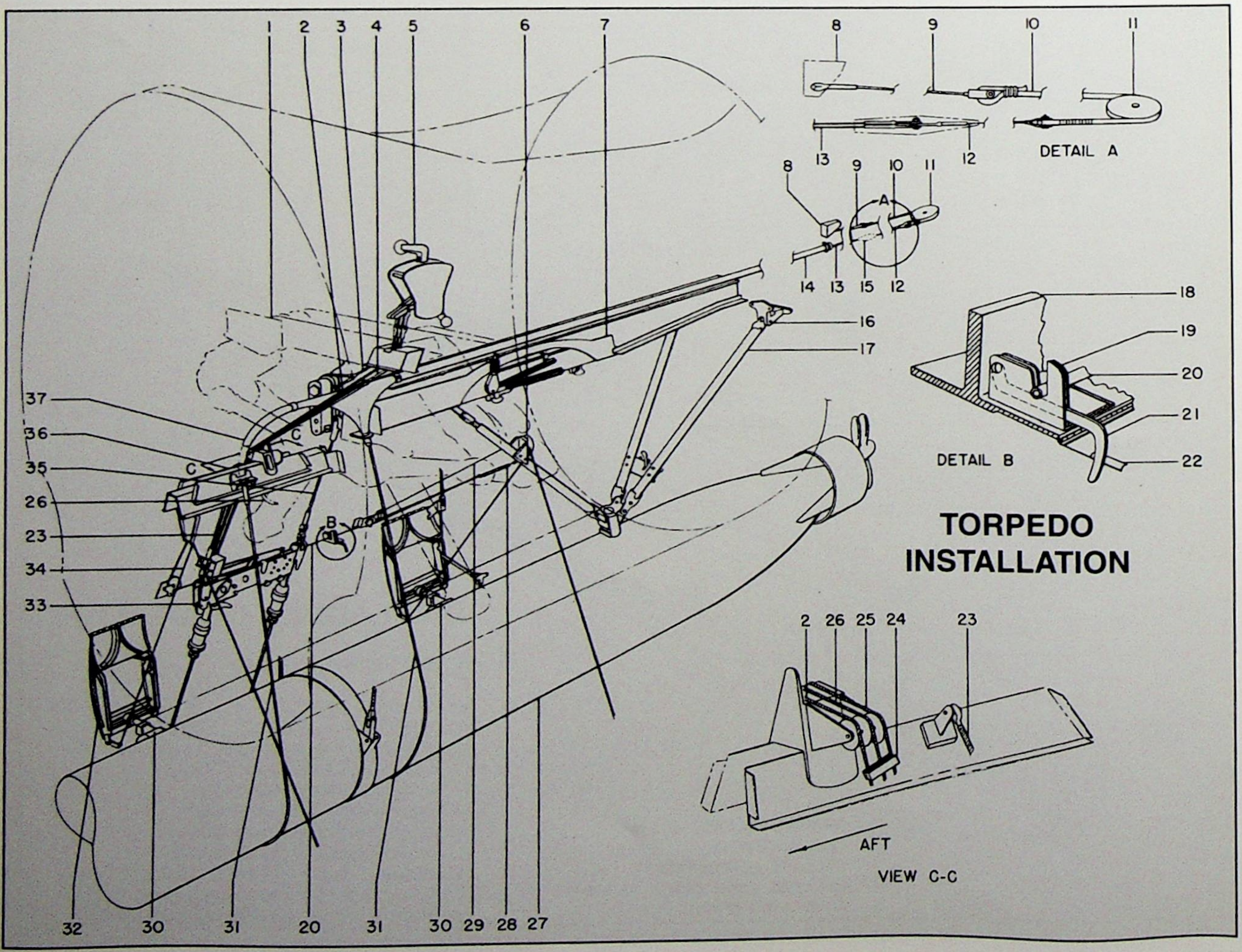
1.) 500 lb bomb
2.) 650 lb depth charge
3.) 1000 lb bomb
4.) 1000 lb aircraft mine
5.) 1600 lb bomb
6.) 2000 lb torpedo

In the event of an electrical failure the Mark IV bomb release quadrant located on the forward left console provided the manual back-up. The bomb release quadrant was equipped with two levers, the one on the bottom of the quadrant armed all the bombs while the top lever, through selective positioning, could be used to release individual bombs. There was no manual salvo capability.

There also was a provision for carrying an externally-mounted torpedo. However, when used to carry a torpedo the bomb bay doors remained fully closed and the sway brace assemblies, hinged at the door line, were lowered for the torpedo installation, thereby eliminating the use of the bomb bay for any other form of ordnance.[10] The torpedo would have been dropped by selecting the Armament Master Switch to "ON", the Rack Release switch to "BOMB BAY", before releasing the torpedo either electrically through the button on the control stick or manually by moving the handle in the center slot of the bomb release quadrant "AFT".

Other items that could be carried included a target tow container or a smoke tank mounted on the port wing bomb rack. The controls for their operation were located adjacent to each other on the top of the left console and included a tail pipe control for the smoke tank installation. The tail pipe control was a T-shaped handle located on the side panel of the left-hand console that had the following three positions: "LOW", "INTERIM" and "HIGH" for when the T-handle was pulled full aft.

In conformance with the Navy's requirement for this new class of airplane, the XBTC-2 was equipped with four wing-mounted 20 mm cannons. The guns were provided with 200 rounds of ammunition per gun and were sighted so that the center lines of the guns converged on the center line of the gunsight at 400 yards. To be fired, the pilot needed to select the Armament Master switch to "ON" then select the desired set of guns before



pressing the trigger on the control stick. The individual sets of wing guns could be selected through the use of two gun selector switches, one labeled "OUTBOARD" and "OFF", the other, "INBOARD" and "OFF", located on the armament switch panel. In the event of a jammed gun, two gun charging handles were located in the left side of the armament switch panel with the left handle controlling the left wing guns and the right handle, the right guns. To charge a set of guns, turn that handle to "FIRE" and push it in. To lock the guns, turn the handles to "SAFE" and push them in. The Landing check list included:

(7) Armament Master Switch-"OFF"

(8) Gun Charging Knobs-turn to "SAFE" and push in.

The aircraft was equipped with a wing-mounted gun camera. The three-position gun camera switch was located on the armament panel. When "WITH GUNS" was selected, the trigger operated the camera, When "WITH BOMBS" was selected, the bomb release button on the control stick operated the camera. The third position was "OFF".

LIMITATIONS:

The following limitations were the same for either the conventional wing panel or duplex panel configuration of the XBTC-2:

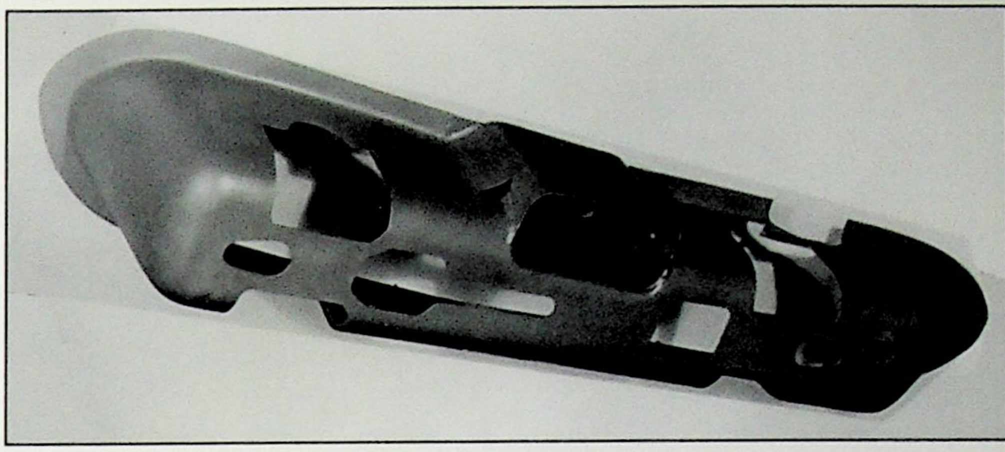
Military Rated Power (5 minute limit) 2700 RPM and 52" Hg
Normal Rated Power (No time limit) 2550 RPM and 43.5" Hg
Maximum Indicated Air speeds:

Altitude	**Kts**
Sea Level	**391**
5,000 ft	**365**
10,000 ft	**340**
15,000 ft	**281**
20.000 ft	**258**
25,000 ft	**239**
Flaps	**130**
Slats	**130**

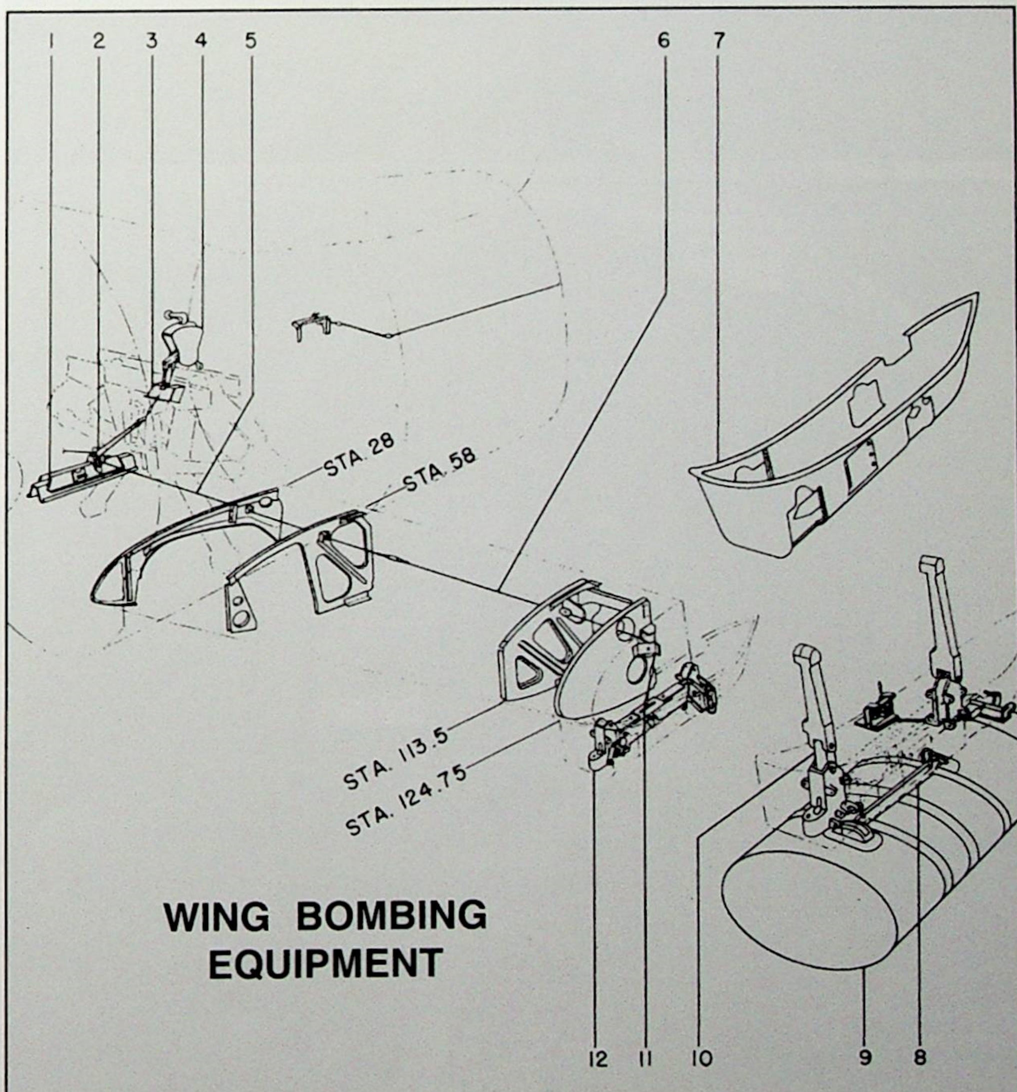
No aerobatics except for dive entries and the following specific maneuvers were allowed: loops, chandelles, Immelmans, wing-overs, vertical turns, and aileron rolls with a maximum indicated airspeed for full aileron deflection of 310 knots and a 2 g limit. Specifically prohibited were snap rolls and intentional spins.

Maximum Permissible Accelerations both wings:

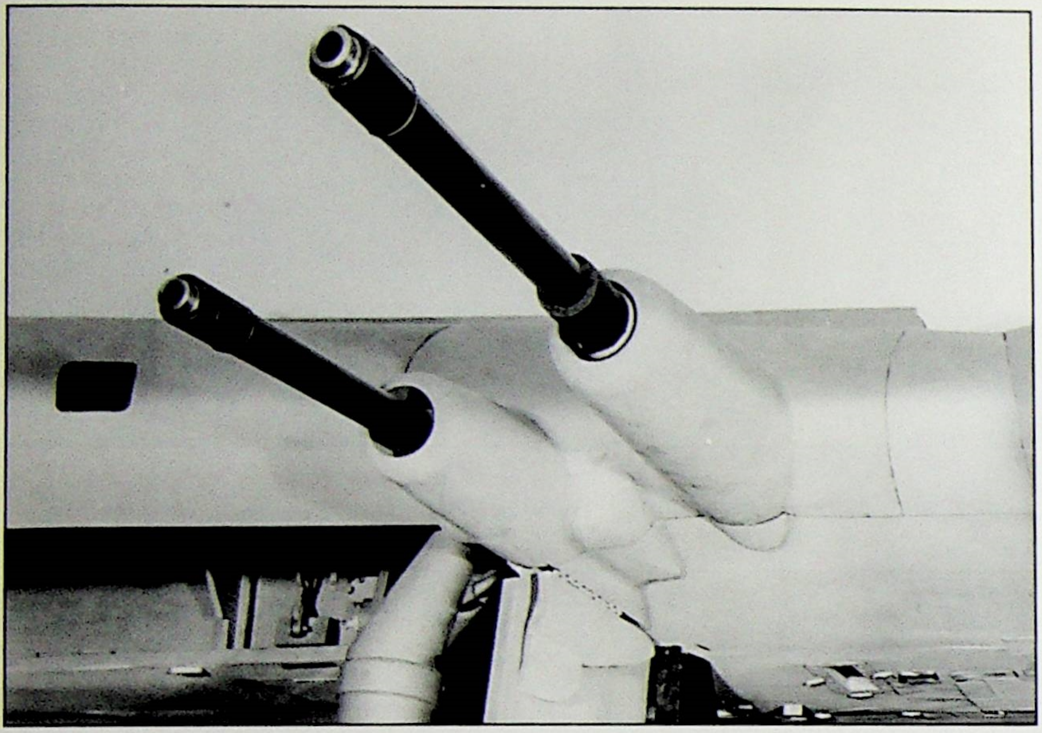
Up to 18000 lbs	4.0 g's
18001-21900 lbs	3.0 g's

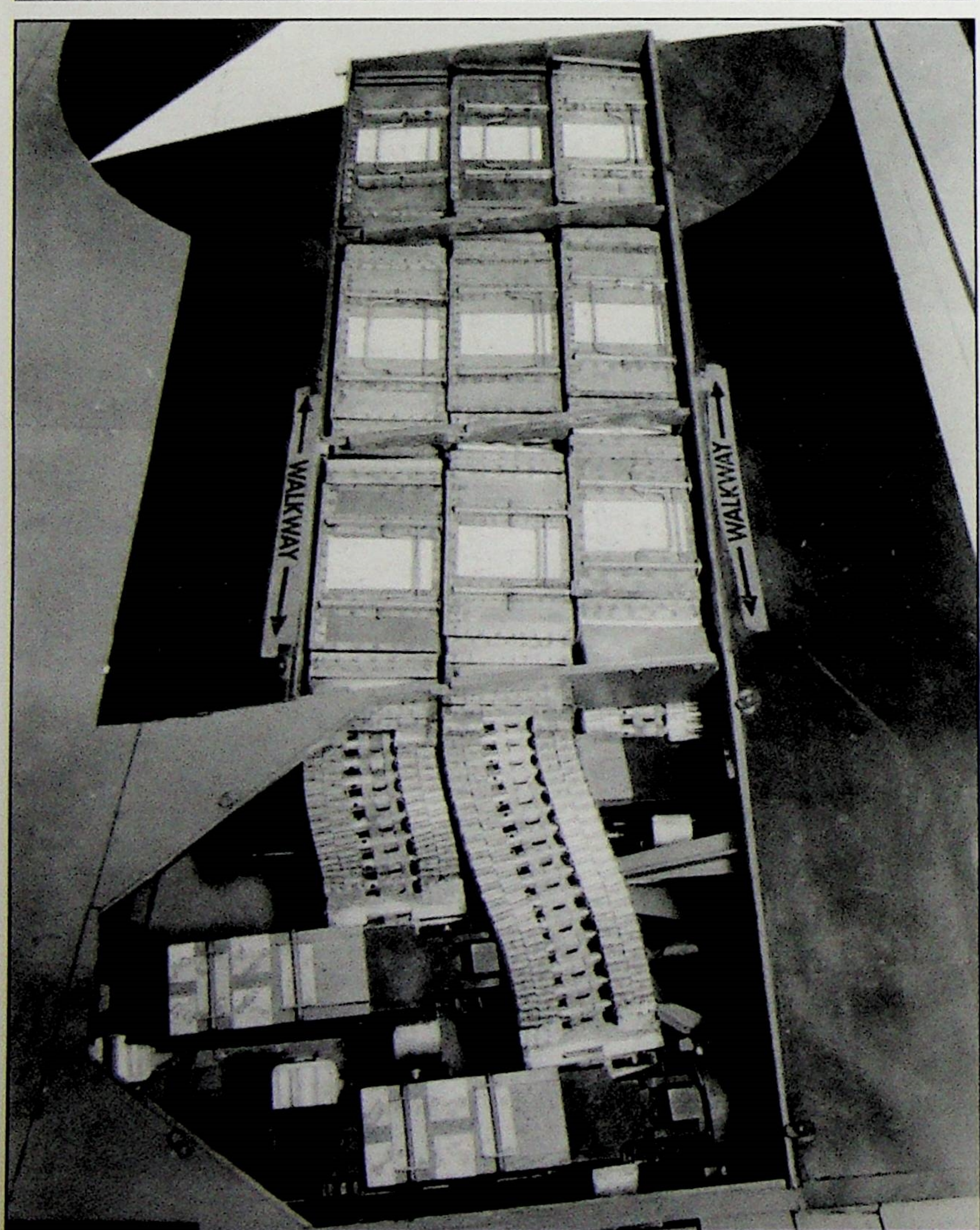


Above, wing pylon bomb fairing. (National Archives)



1	98-680-1095	BEAM ASSEMBLY
2	98-681-1051-2	CABLE ASSEMBLY
3	98-680-1046	BRACKET
4	BO 375-602	MK 4. MOD. 2 BOMB RELEASE HANDLE
5	98-681-1051-1	CABLE ASSEMBLY, WING BOMB RACK
6	98-681-1027 L	CABLE ASSEMBLY, WING BOMB RACK
7	98-681-1030	FAIRING INSTALLATION
8	BO-330-856	AIRCRAFT TARGET CONTAINER ADAPTER
9	98-681-1020	TARGET CONTAINER
10	98-681-1013	LINK
11	98-681-1028	CABLE ASSEMBLY, WING BOMB RACK
12	98-681-1031	SWAY BRACE ASSEMBLY





These g-limits were drastically lower than the 7 g's that was the normal limitation for BT-class of airplane. That leads me to believe that the lower g-limits were imposed to satisfy the experimental status of XBTC-2. If the XBTC-2 was to have been used as an operational BT class airplane, Curtiss-pilots would have had to demonstrate that the XBTC-2 could meet the BT class limits of 7.5 g's at some operationally-significant (as in, pull-out from a dive-bombing attack) specified altitude and airspeed. Then, as was customary, the pilot's handbook would have shown a lowered 7.0 g's as its XBTC-2 Acceleration Limit at some designated weight, probably that 18,000 lbs. In squadron use, the pilot would turn to the Operating Strength Diagram[11] of the Pilot's Handbook to check that his configuration was within the "Envelope" of safe operating airspeeds and g limits. All of which was offered to support the author's contention that these lower g-limits were imposed to support the XBTC-2's use in its experimental status and not for any future use with the fleet.

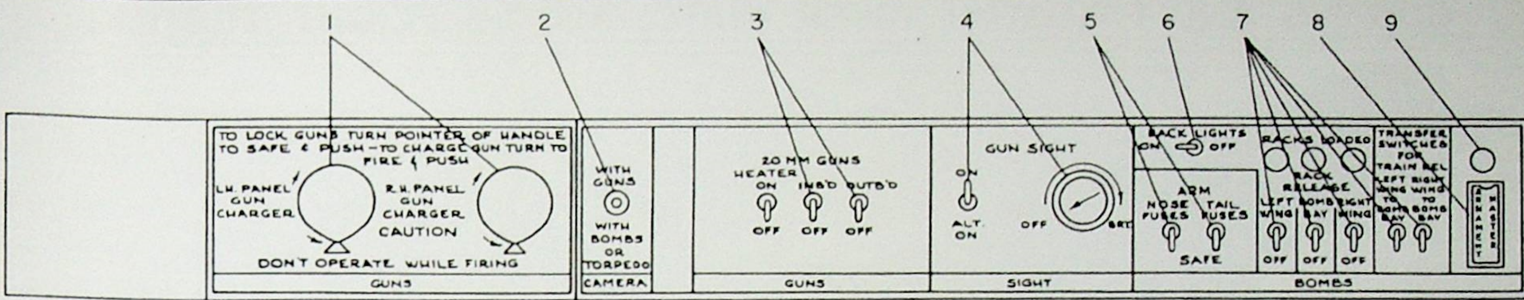
Both aircraft history cards have an acceptance date of 30 July 1946 with BuNo 31401 being listed as "Stricken" in Dec 1947 and BuNo 31402 on 31 March 1947. Neither history card showed any flight time. For its epilogue, about all that I can offer is that even though the XBTC-2s served by evaluating two new technologies, in the end neither the duplex wing nor the contra-rotating propeller found use with the fleet.

FOOTNOTES:

1 When accepted by the Navy, BuNo 31401 was powered by the XR-4360-8A (the X designator standing for Experimental and the suffix A for semi-production) while BuNo 31402 was powered by an R-4360-14, the production version of the R-4360-8A engine.

2 That logo looks as if it was Pratt

At top left, 20mm gun installation in the XBTC-1 mock-up on 29 December 1942. Installation in the XBTC-2 was identical. (National Archives) At left, XBTC-1 wing gun access and ammo box installation on the mock-up on 30 December 1942. This arrangement was modified on the XBTC-2. (National Archives)



1.) GUN CHARGING HANDLES
2.) GUN CAMERA SWITCH
3.) GUN SELECTOR SWITCHES
4.) GUN SIGHT CONTROLS
5.) BOMB ARMING SWITCHES

ARMAMENT SWITCH PANEL

This panel was attached to the bottom of the instrument panel

6.) RACK LIGHTS SWITCH
7.) BOMB SELECTOR SWITCHES
8.) ARMAMENT MASTER SWITCH
9.) BOMB BAY DOORS INDICATING LIGHT

& Whitney's Wasp and that couldn't have set well with Curtiss-Wright.

3 Section II, Paragraph 1-8 Pilot's Handbook

4 The Propeller Division of Curtiss-Wright.

5 The propeller division of Allison, itself a division of General Motors Corp.

6 Eclipse in 1943 was part of the Eclipse-Pioneer Division of Bendix Aviation who also provided the ignition system and carburetor for our R-4360s.

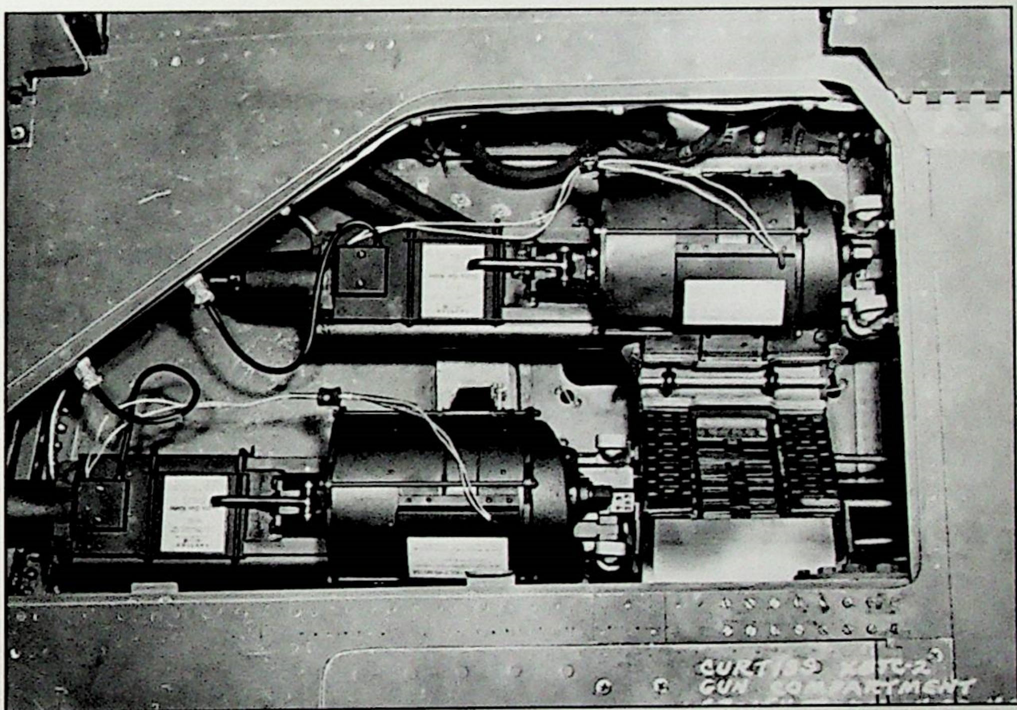
7 I feel certain some ready room pundit would have added, "It may reach 400 psi but not for long!".

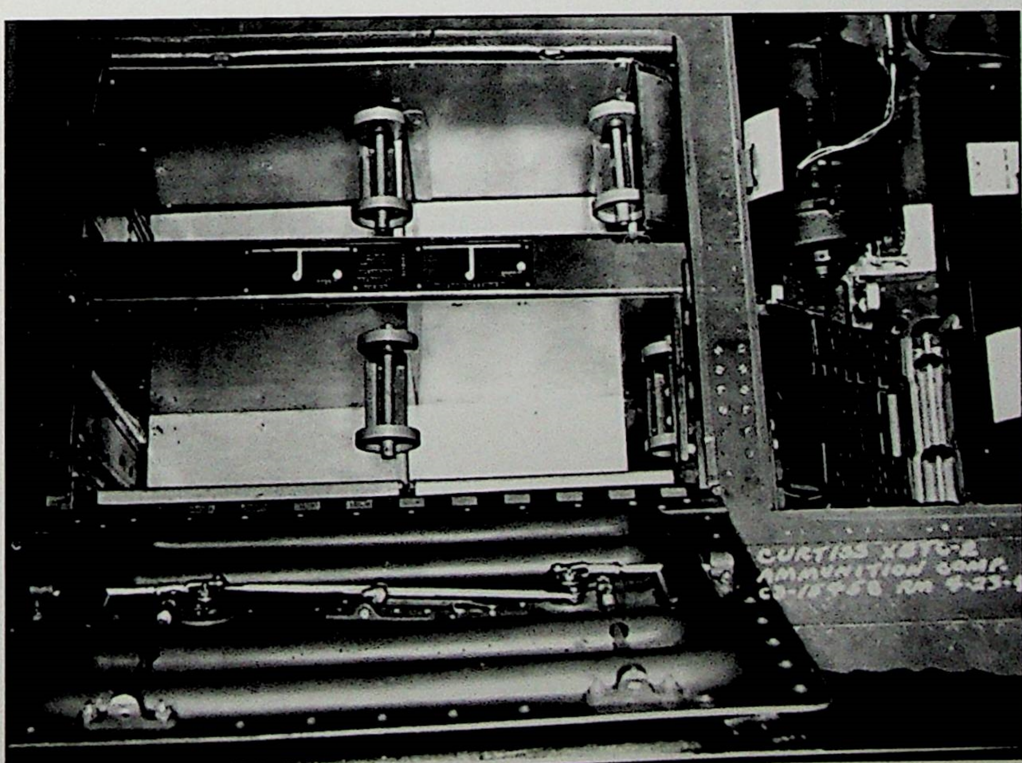
8 Probably a Sperry S-3 auto pilot as used on the Douglas XTB2D-1.

9 The vacuum was provided by an engine driven vacuum pump with a normal suction pressure of 4 psi.

10 When not in use, the sway brace assemblies did form part of the bomb bay door surface.

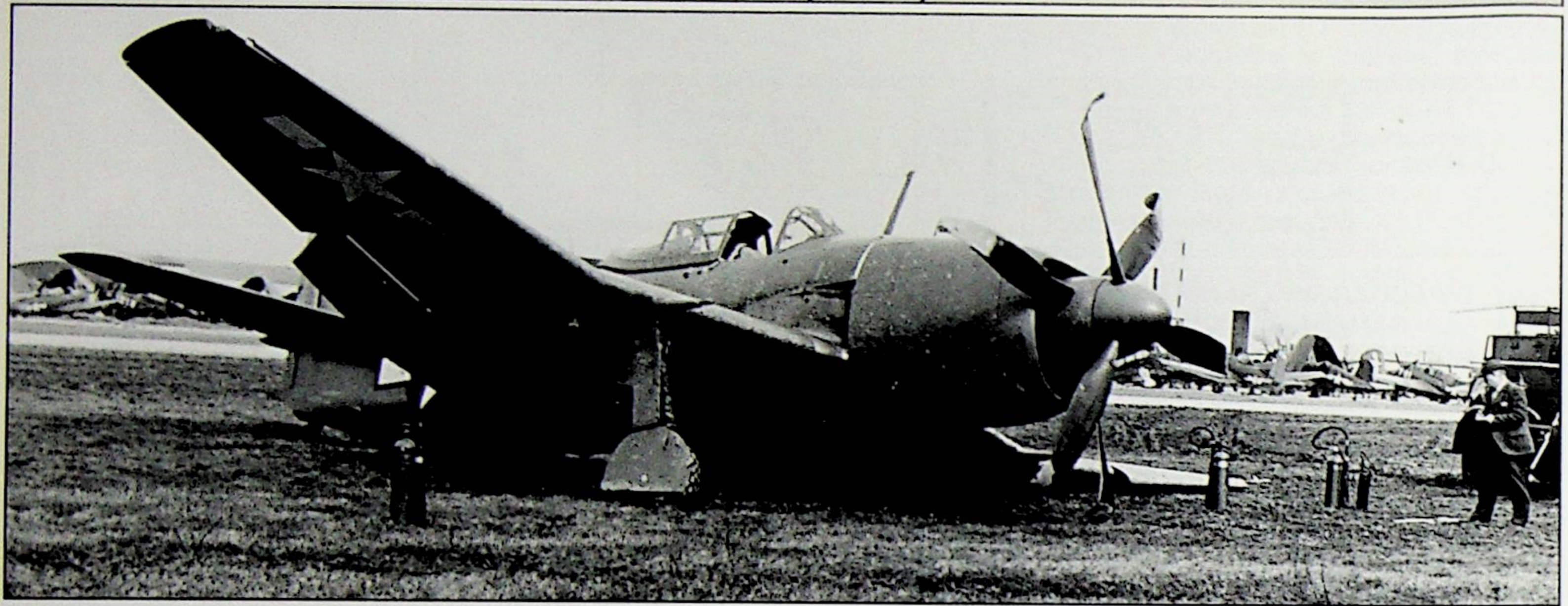
11 Later known as the Flight Strength Diagram.





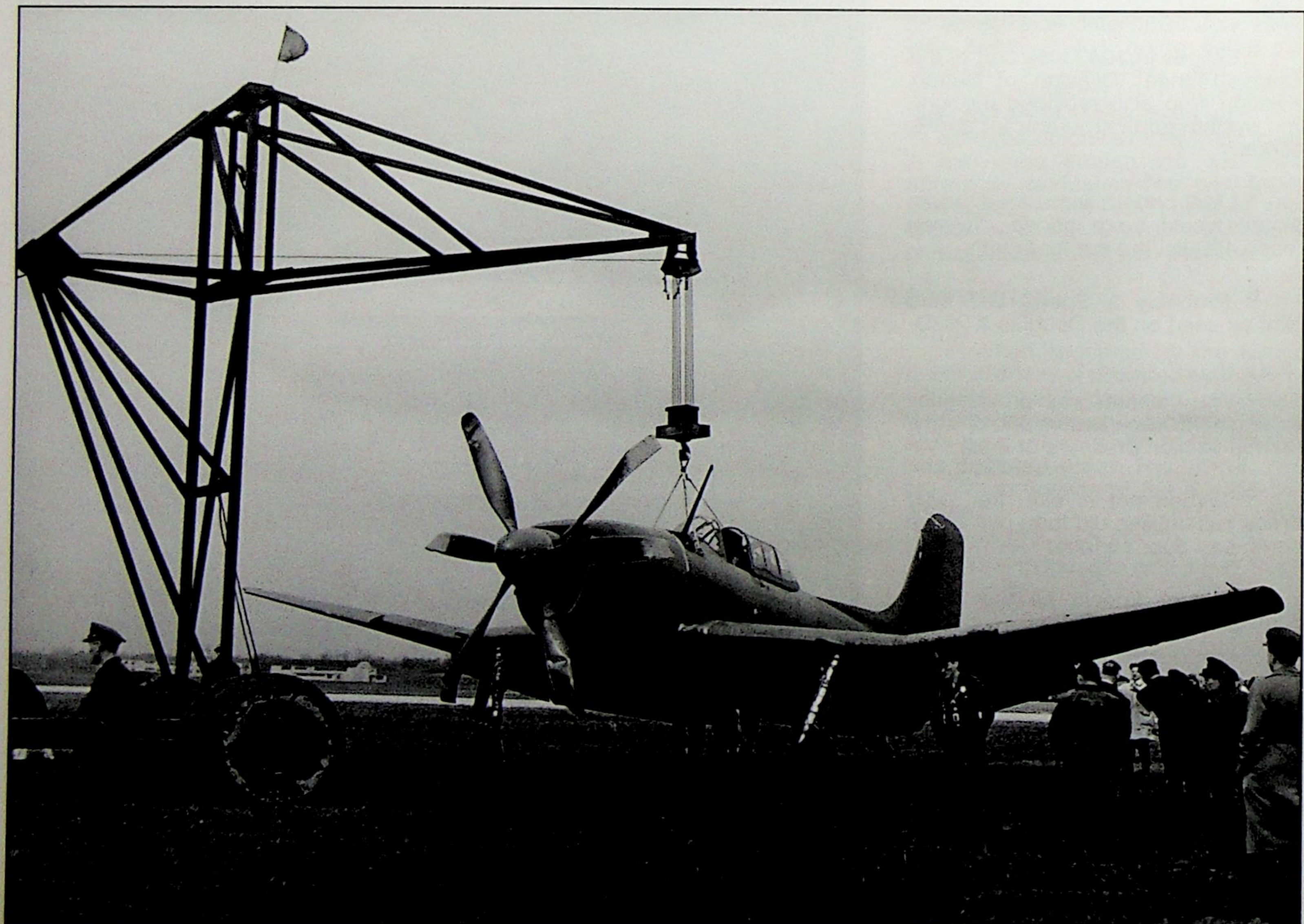
Above right, XBTC-2 wing gun access on 25 April 1945. (National Archives) At right, the XBTC-2 ammunition compartment door opened aft. (National Archives)

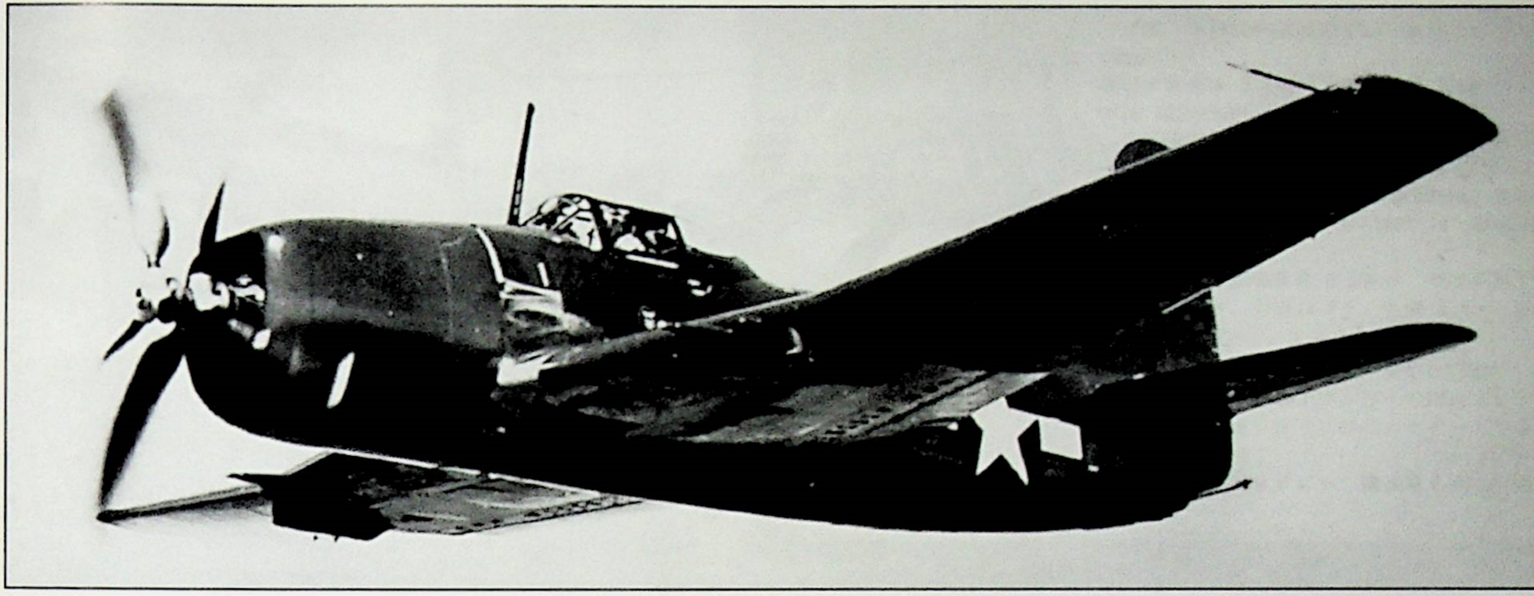
CURTISS AND PATUXENT RIVER (NATC) XBTC-2 FLIGHT TESTING



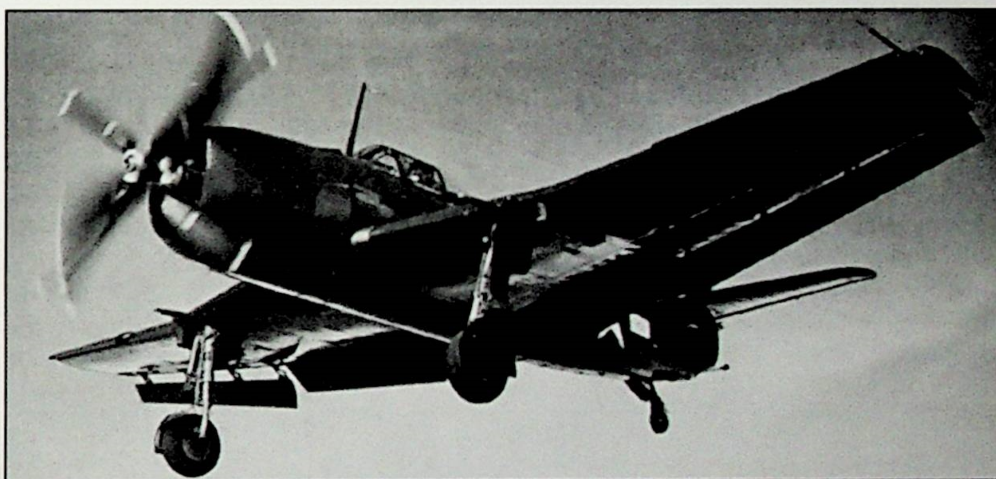
After its first flight in January 1945, the XBTC-2 flight test program progressed slowly with a flight line cockpit fire and a 3 March 1945 landing gear accident. The left main gear down lock failed and the aircraft departed the runway when the gear collapsed. Stress surveys of the Curtiss propellers lead to their replacement with Aeroproduct units. This was followed by groundings caused by

Above and below, XBTC-2 BuNo 31401 after the left main gear down lock failed on 3 March 1945. (NMNA and USN via Craig Kaston)

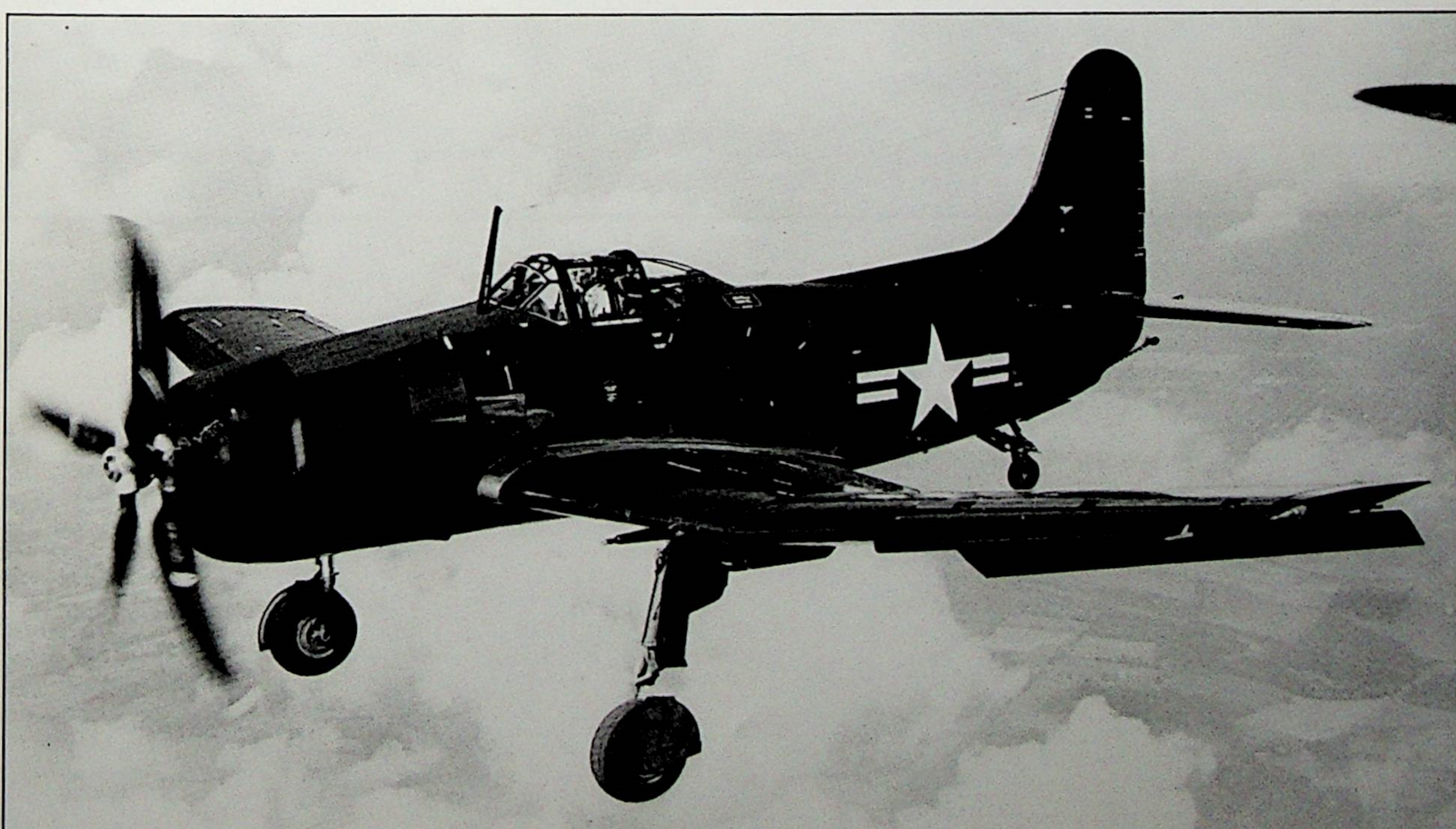


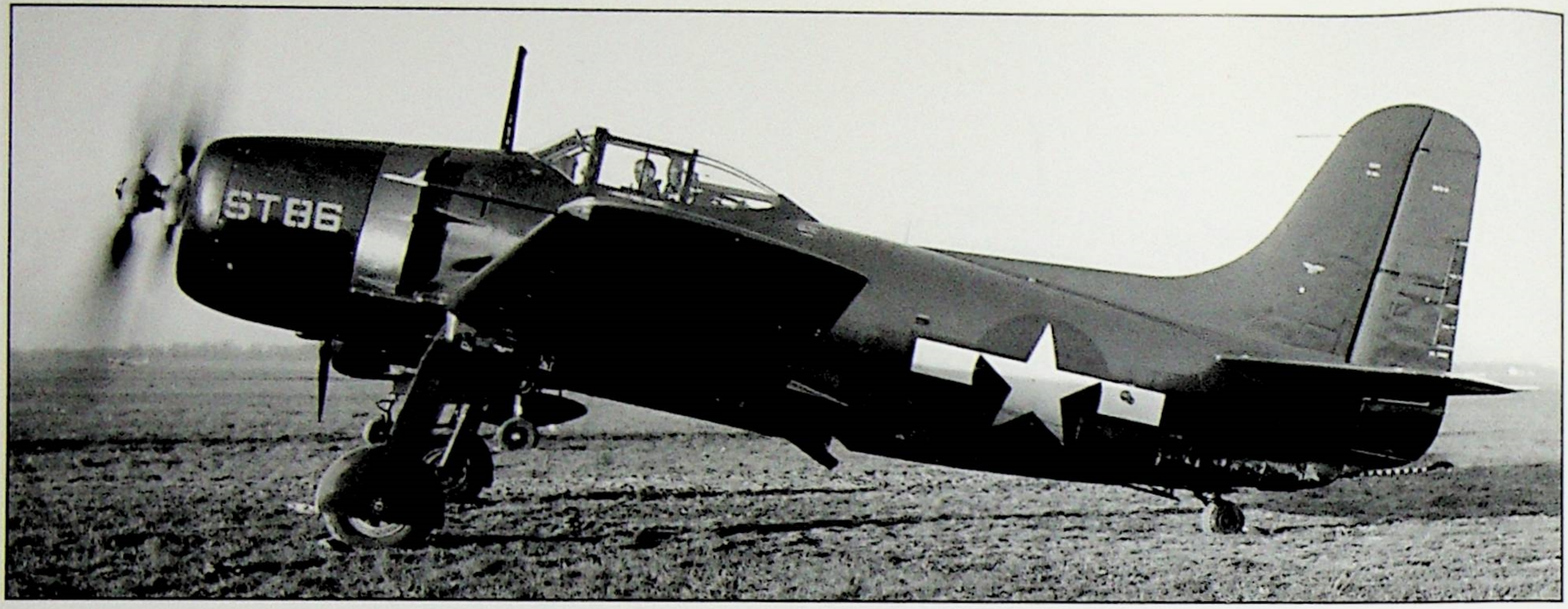


Above, early test flight of duplex-winged ship #2, BuNo 31402, (USN) At right and below, ship #2 in slow flight with gear, duplex flaps and slats extended. (USN and via Stephane Nicolaou)



problems with the propeller drive gears. Late in 1945, the Model A outer wing panels were replaced with the Model B duplex wing panels on ship number one. Both ships were

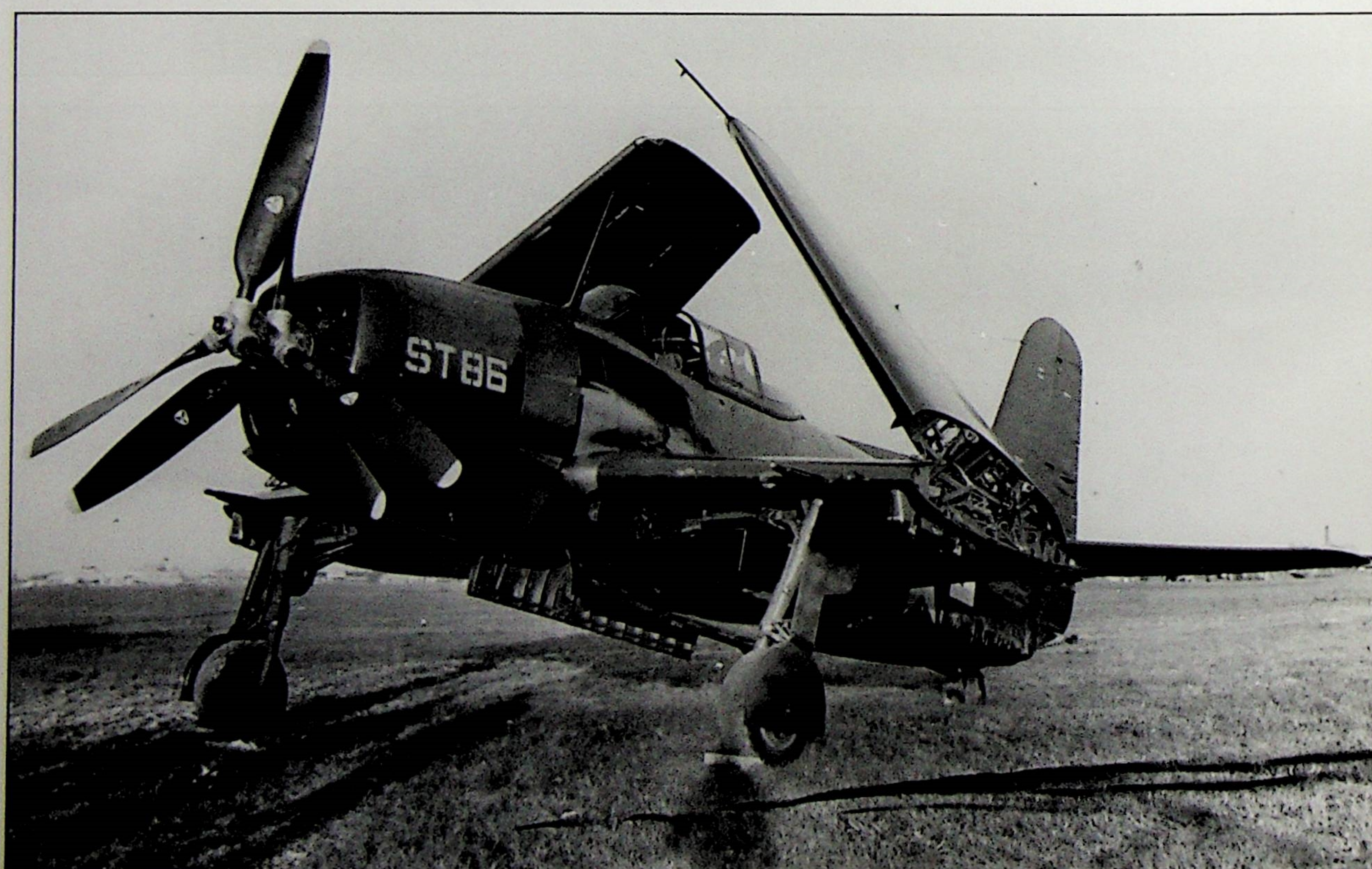


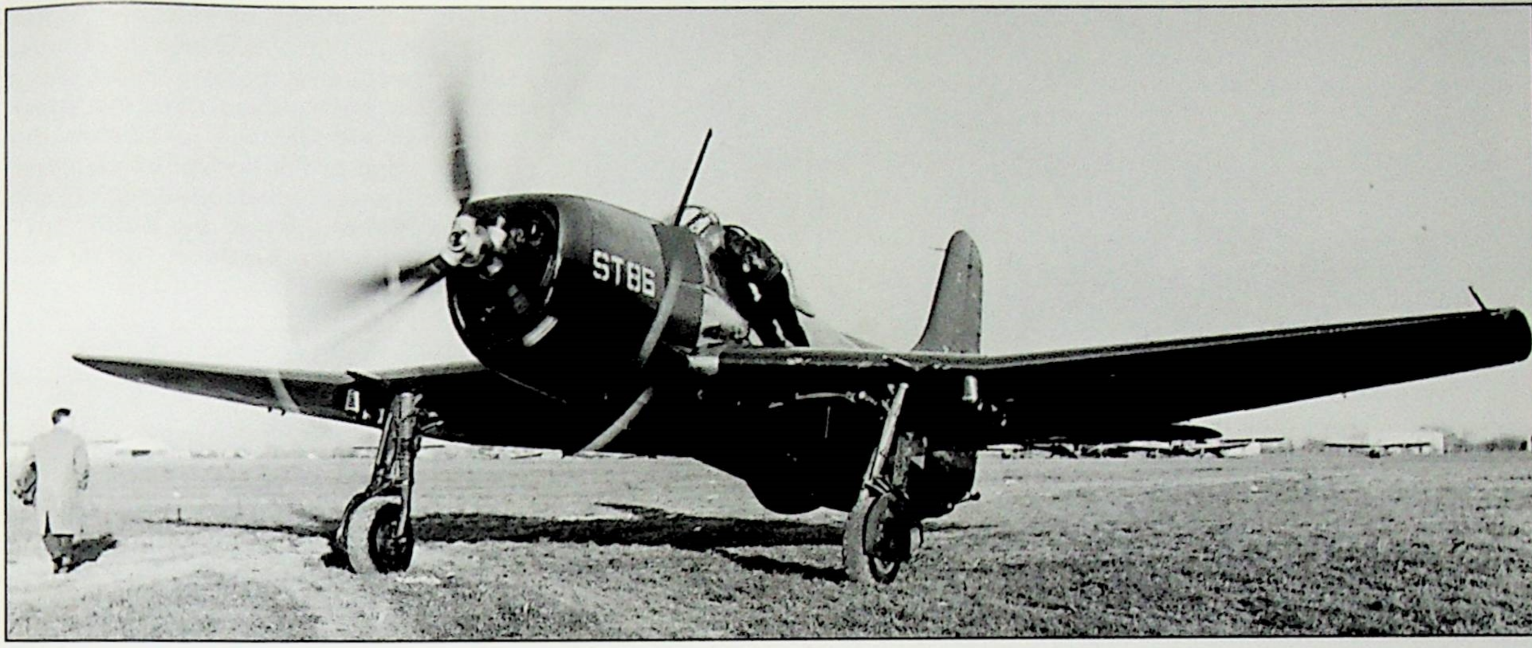


Above and below, BuNo 31401 at Curtiss on 17 November 1946. "ST-86" on the nose was painted in yellow and stood for Service Test aircraft #86. At NATC the XBTC-2 was called the "Eggbeater" (Jim Hawkins via Norm Taylor and NMNA)

delivered to the Naval Air Test Center (NATC), Patuxent River, MD, in July 1946. The aircraft were assigned to both the Flight Test (FT) and Service Test (ST) Divisions.

Ship two was destroyed in a crash landing on 17 March 1947 after the engine seized during stall tests. Piloted by LT Louis T. O'Neill USCG of the Flight Test Division, BuNo 31402's planetary pinion gear failed during the stall, sending metal particles thoughout the engine. This resulted in a loss of oil pressure and subsequent engine failure. The aircraft pancaked into a soft field in a three-point attitude with the gear down. The impact sheared off the right main gear and collapsed the left one. The aircraft slid an additional 50

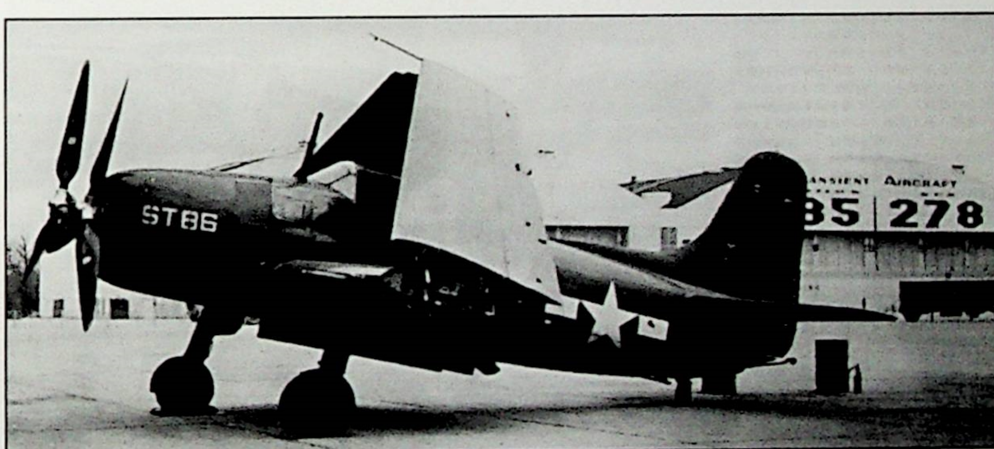


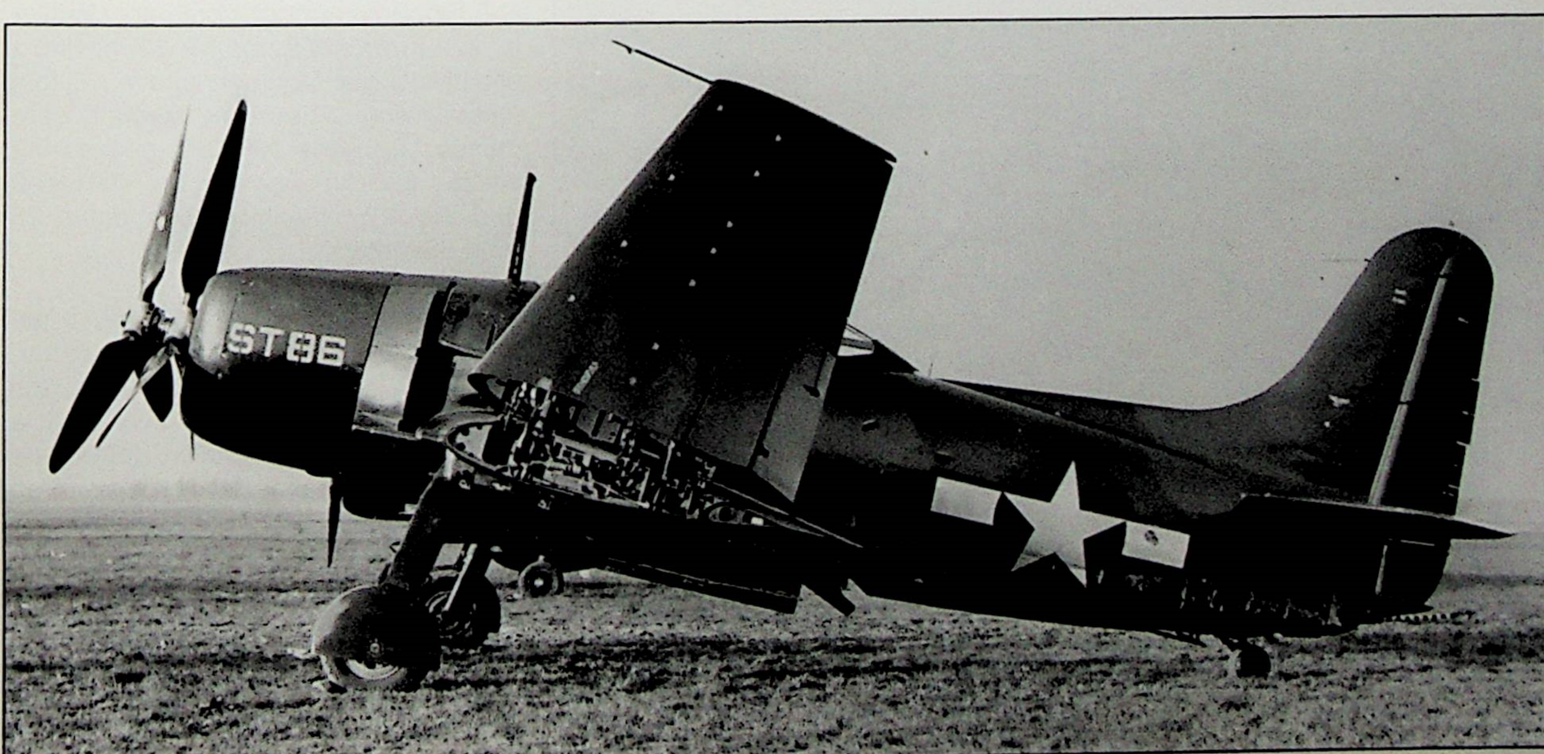


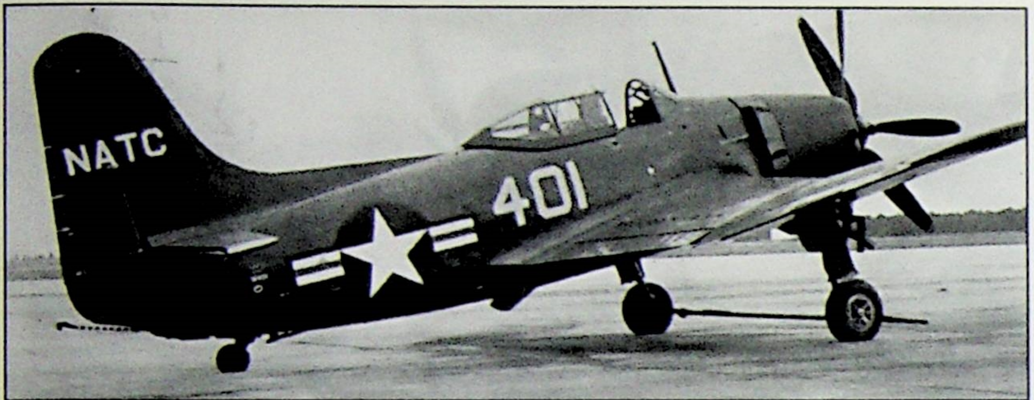
yards from the point of impact before stopping and catching fire. The impact caused the canopy to slam forward to within four inches of the closed position and jam. Two sailors reached the aircraft within a minute of impact freeing the jammed canopy and rescueing the pilot. LT O'Neill suffered a lacerated and fractured left arm and wrist.

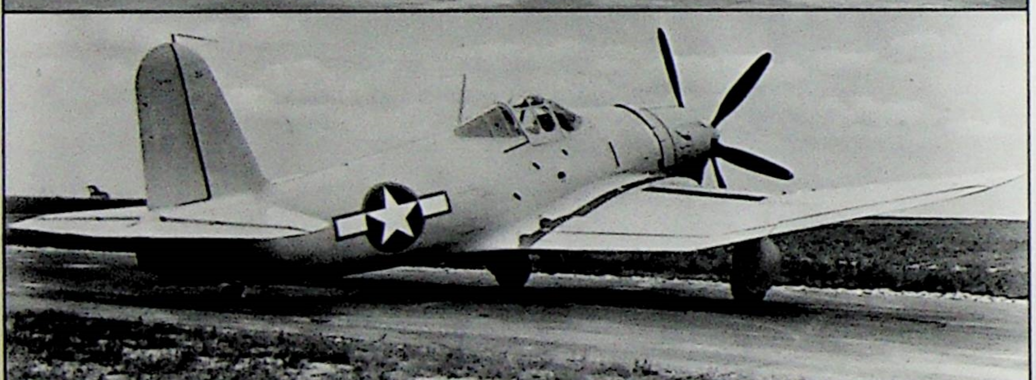
The first aircraft continued to be tested at NATC until August 1947 when it was transfered to the Naval Air Material Center (NAMU), Philadelphia, PA.

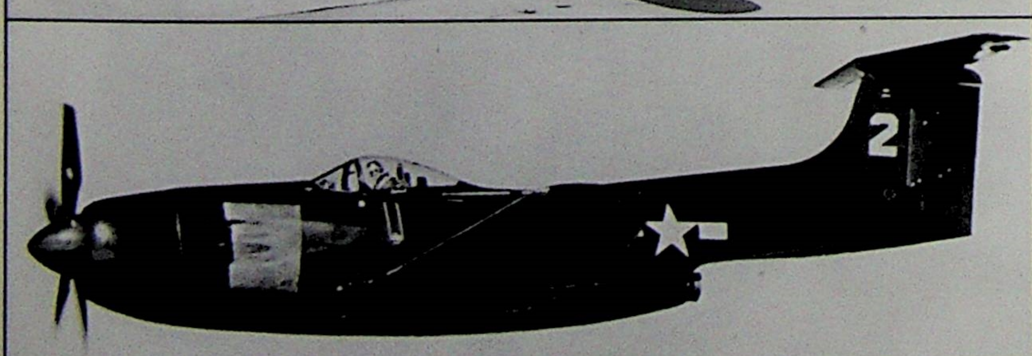
Above, pre-flight runup of BuNo 31401 in November 1947. (NMNA) Below, two views of folded wing on BuNo 31401 with duplex wing installed. (NMNA)



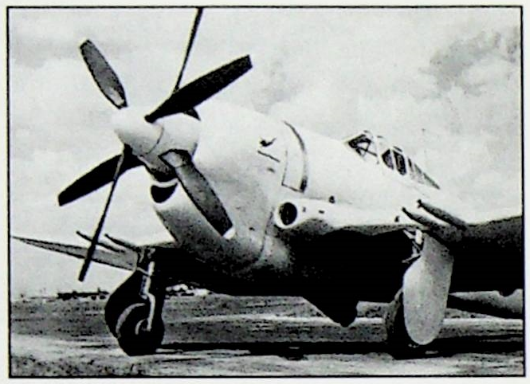








At left, two photos of ship one, BuNo 31401, in its final markings in August 1947. The aircraft's designation, Navy and BuNo were moved from the upper tail to the aft fuselage just below the leading edge of the horizontal stabilizer and NATC was applied to the vertical tail. The last three digits of the BuNo "401" was added to the fuselage. (Ginter collection)



The XBTC-2 was not the only Curtiss counter-rotating, propeller-driven aircraft. Three others were built, one for the Navy and two for the Army. The Navy ship was the XF-14C-2 (above and at left) heavy fighter powered by an R-3350 and armed with four 20mm cannon. It first flew in July 1944, but with a top speed of 398 mph, it was only marginally faster than the more maneuverable F6F-3 Hellcat and slower than the latest versions of the F4U Corsair and the new F7F Tigercat then entering service. The Army aircraft were the XP-60C (at left) with an R-2800-53 and the XP-62 powered by an R-3350. Both aircraft were very simiular in appearance with the XP-62, having a slightly longer fuselage and a 12 foot longer wing. The Army aircraft were cleaner with the XP-60C possessing similar performance to the XF14C-2 and the XP-62 exhibiting about a 25 mph advantage.

The last Curtiss aircraft built for the Navy was a composite heavy fighter, the XF15C-1 (at bottom left). It was powered by an R-2800-34W and a British DeHavilland "Goblin" jet engine built by Allis-Chalmers. The big aircraft first flew on 27 February 1945. After a crash and modification to a "T" tail, two were accepted at NATC in November 1946. Although much faster than the above-mentioned aircraft, at 469 mph it was evident that the rapid development of jet aircraft eliminated the need for a composite aircraft.

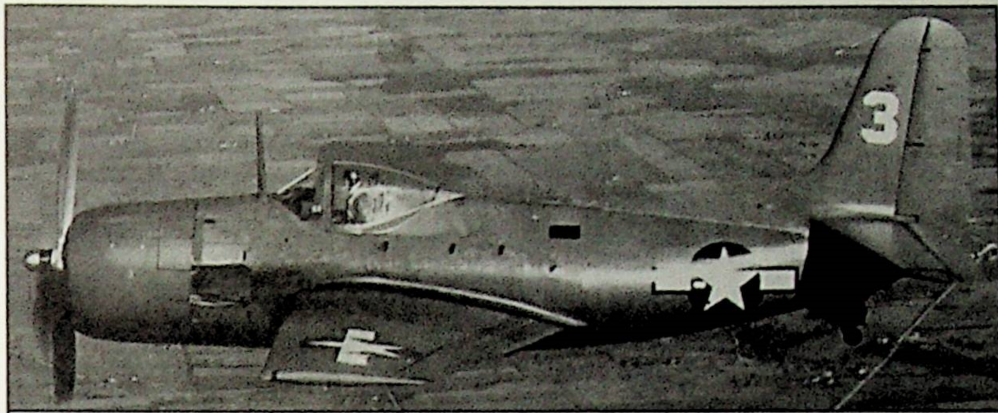
BOMBER TORPEDO PROGRAM AIRCRAFT

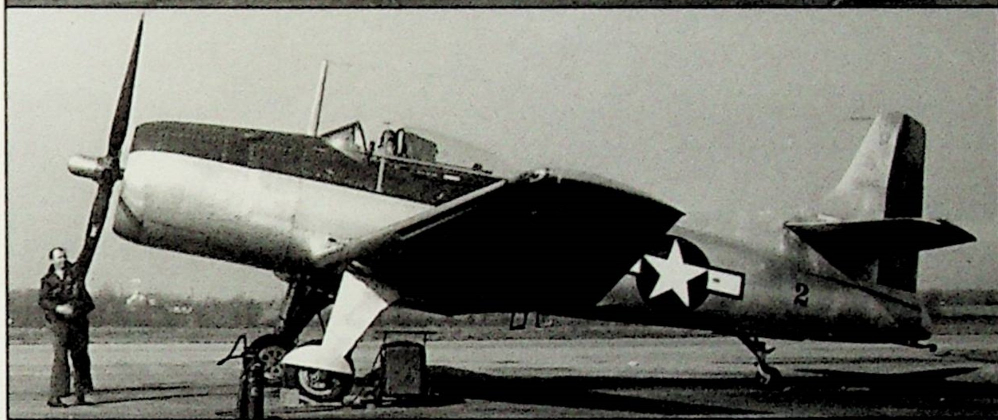
Curtiss was contacted for a second contender in the BT program. It was the R-3350-powered XBT2C-1 (at right). Nine were built versus the two XBTC-2s as it exhibited much more promise in its intended mission. It could carry a second crewman in the aft fuselage and was capable of carrying a torpedo internally.

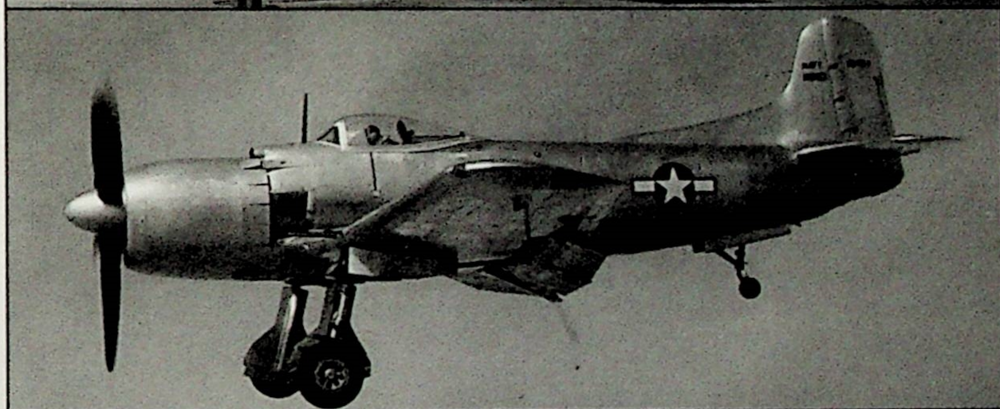
A smaller aircraft designed around an R-2800 and built largely of stainless steel was the XBTK-1 (at right) built by Kaiser Fleetwings. Although capable of carrying a torpedo, its size and structure suggest it was designed specifically for use on the light/escort carriers then being produced by Kaiser.

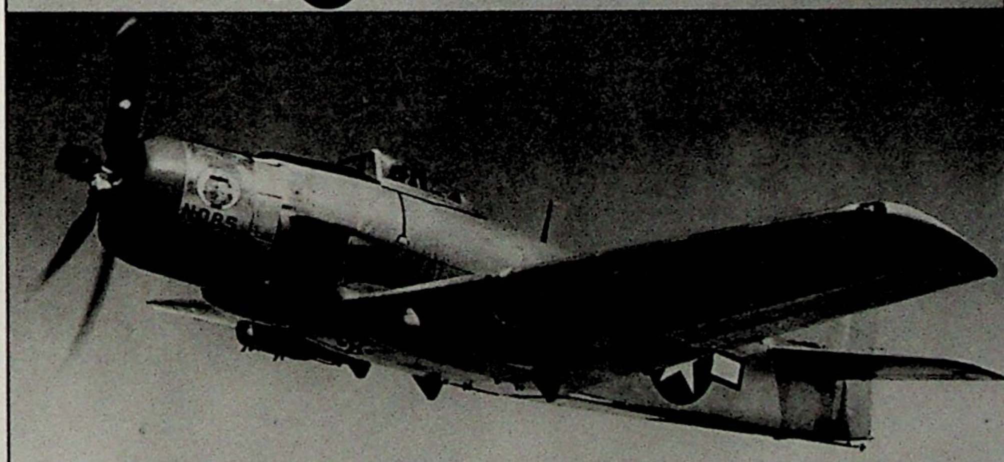
The runner-up and back-up aircraft of the BT program was the Martin XBTM-1/AM-1 Mauler of which 151 were built. It was a brute of an aircraft with its corncob R-4360 when compared to the program's winner, the XBT2D-1/AD Skyraider. The AM-1 Maulers (at right) were operated by fleet squadrons VA-17A/VA-174, VA-44, VA-45, VA-84 and VA-85 before being passed on to the reserves. The AM-1Q saw service with VC-4 until 1 October 1950.

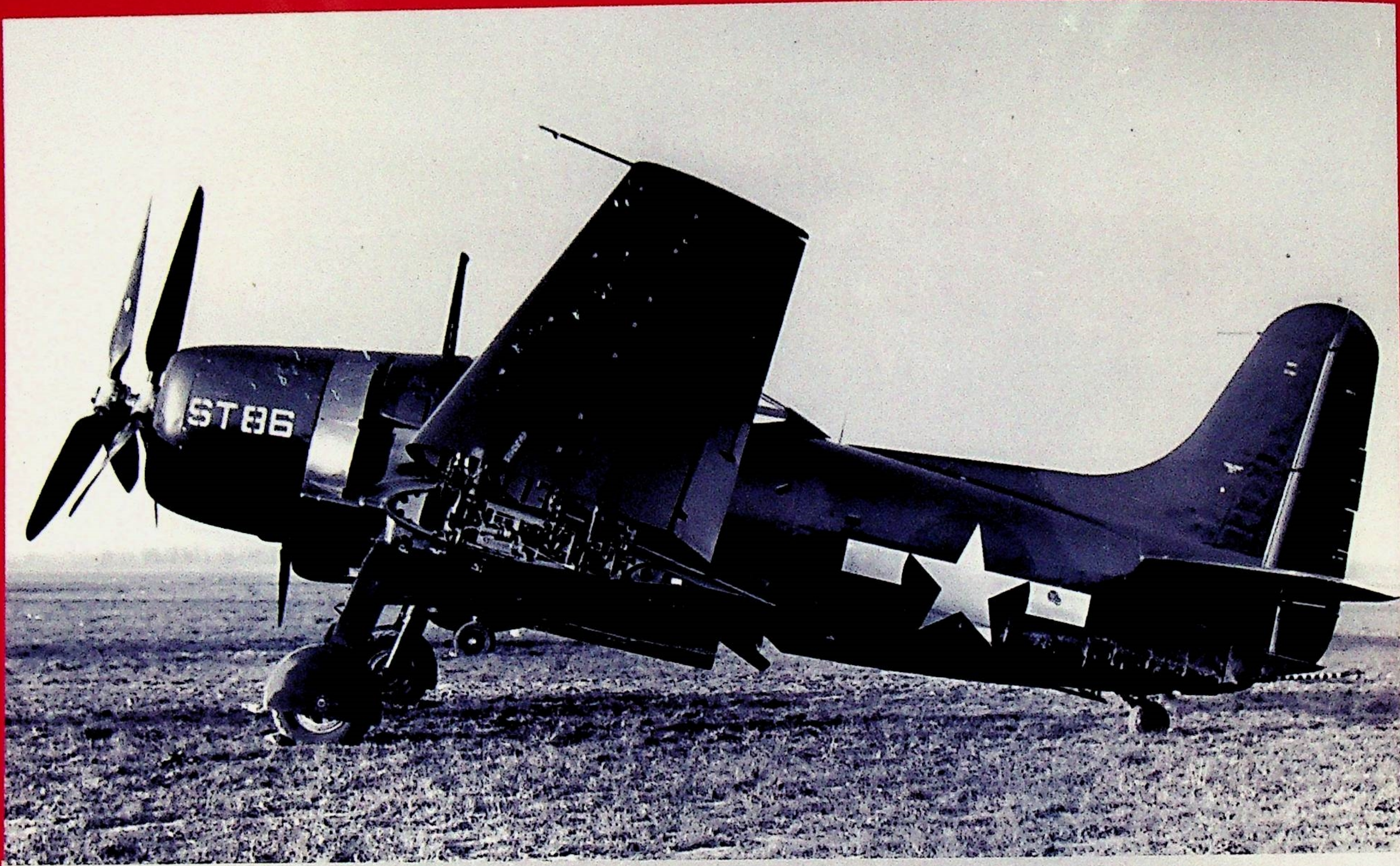
Although Douglas was not originally included in the BT competition, it would build three BT-type aircraft before building and flying the BT winning design, the R-3350-powered (at right) AD Skyraider (XBT2D-1) eight months before the Martin Mauler. The first of the three predecessors to the AD was the XSB2D-1 Destroyer that was already under development when the original BT contracts were issued in September 1943. The XSB2D-1 was equipped with an internal bomb bay, two 20mm wing guns, and four .50 caliber guns in remotely-controlled top and bottom power turrets. The XSB2D-1 was redesignated into a single-seat bomber and the power turrets were removed. It was redesignated BTD-1 (at right) and still called the Destroyer. The BTD-1 was rolled out in December 1943.

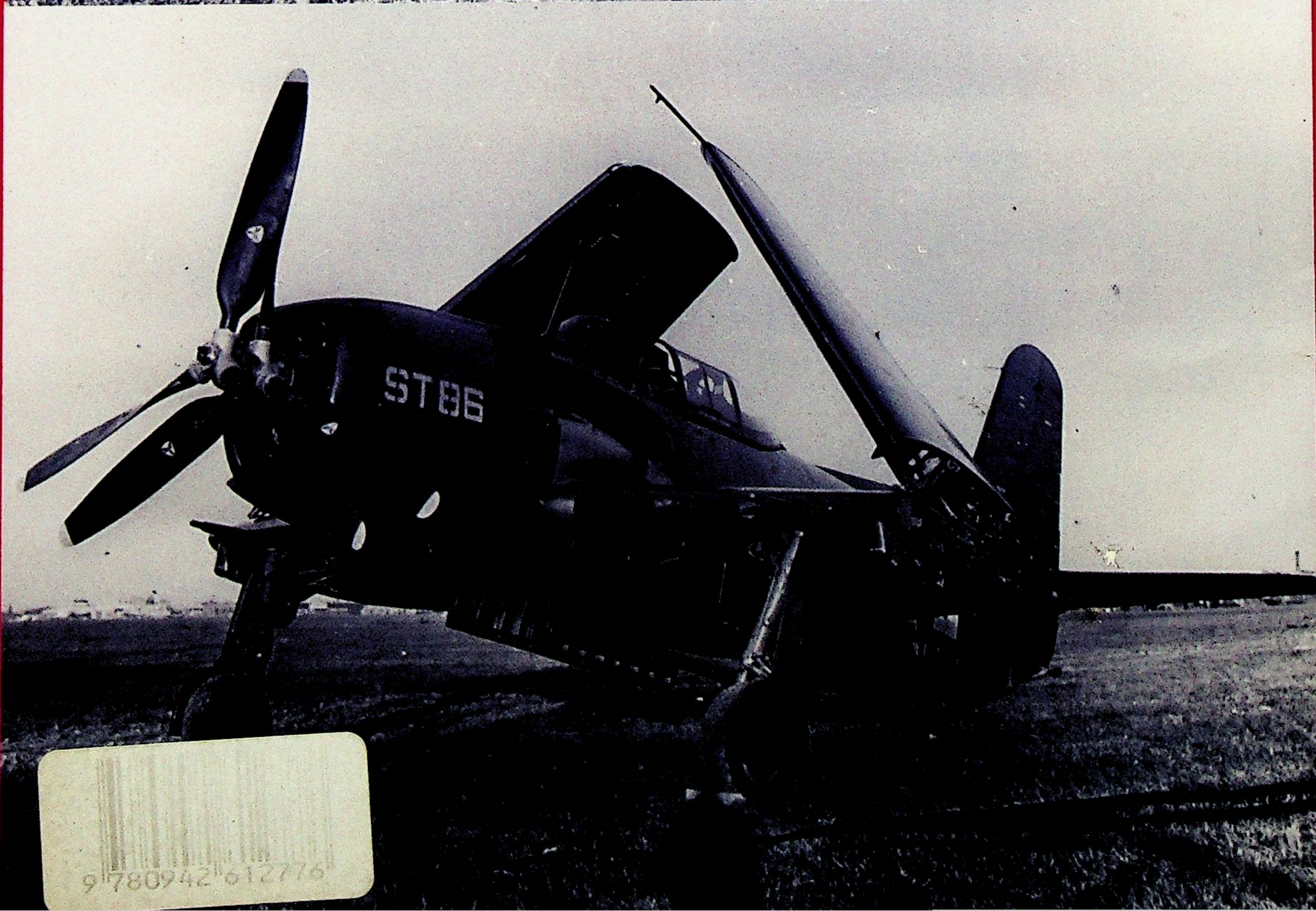












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